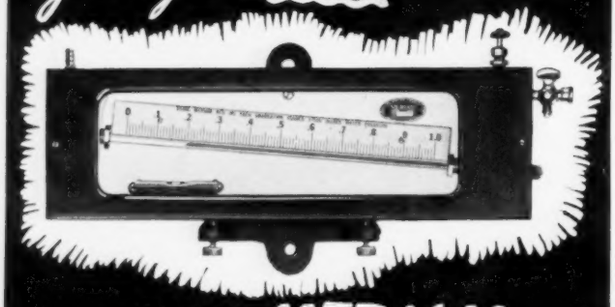
✓ ACCURACY ✓ DURABILITY ✓ CONVENIENCE you get ALL three



WITH MERIAM DRAFT GAUGES

HUNDREDS of firms are gaining efficient combustion and keeping heat losses at a minimum with Meriam Draft Gauges. These valuable gauges soon repay their moderate cost by accurate measurements of pressures, differential pressures, and drafts at various points in boiler settings.

Meriam Draft Gauges are unfailing in their accuracy because they operate on the basic, unvarying laws of gravity and differential pressure. They have no moving parts to wear out.

Moreover, users report years of trouble-free service, from these durably constructed gauges. Aluminum body, dust proof case; and gland packing prevents leakage.

Meriam Draft Gauges are convenient, too: The adjustable mounting bracket insures easy leveling. For periodic checking, the plunger unit offers a quick zero adjustment. Amplified scale range permits easier reading, and the large plate glass cover provides excellent visibility.

In addition to the single tube illustrated, Meriam Draft Gauges are available in two tube and three tube styles. Consult Meriam Engineers about your problem. Write for Bulletin No. 4.

THE MERIAM CO.
Instruments for Indicating Pressure or Flow of Liquids and Gases
CLEVELAND • OHIO
Representatives in Principal Cities

Instruments
THE MAGAZINE OF Measurement and Control

Vol. 14 **FEBRUARY 1941** No. 2

FRONT COVER: Central-station heat-treating room of Reece Buttonhole Machine Co., Boston. Temperature and time controllers, load indicators, etc.
Courtesy C. J. Tagliabue Mfg. Co.

EDITORIAL COMMENT 29
Education and Training Crisis

NEW INSTRUMENTS 31
Indicators, recorders, controllers, inspection devices, etc., for plant, field and laboratory

MICROMANOMETER 37
with illuminated pointers
By Francis C. Morey

AUTOMATIC BALANCE RESTORER 39
using contacts and Thyratrons
By S. P. Sashoff and W. K. Roberts

CALIBRATION ARITHMETIC 40
for both discrete and continuous scales
By Ellis Blade

EDUCATION AND TRAINING 42
A new department. Survey by Richard Rimbach: news of courses at Case, Pitt and Illinois Tech

INSTRUMENTS' BOOK SHELF 44

MISCELLANEOUS ITEMS 50

MANUFACTURERS' NEW LITERATURE A5

ADVERTISERS' INDEX A6

Published Monthly on the 15th by
THE INSTRUMENTS PUBLISHING COMPANY
1117 Wolfendale Street, Pittsburgh, Pa.

RICHARD RIMBACH, Managing Editor — **M. F. BEHAR**, Editor

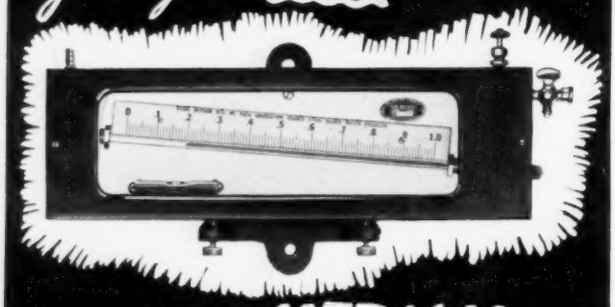
BRANCH OFFICES
Boston: James Condon, 36 Myrtle St. (Lafayette 0829).
New York: R. K. Farnham, 56 W. 45th St. Room 1105 (Murray Hill 2-8763)
Chicago: William Farnham, 201 N. Wells St. (Andover 4180).
Cincinnati: Harold W. Haskett, Keith Bldg. (Parkway 7639).

Annual Subscription: U. S. $2.00. All other countries $3.00 *payable in advance* (remit by New York draft).

Copyright 1941 by The Instruments Publishing Company.

Entered as second-class matter January 2[illegible] 1932, at the post office at Pittsburgh under the Act of March 3, 1879.

✓ ACCURACY ✓ DURABILITY ✓ CONVENIENCE you get ALL three



WITH MERIAM DRAFT GAUGES

HUNDREDS of firms are gaining efficient combustion and keeping heat losses at a minimum with Meriam Draft Gauges. These valuable gauges soon repay their moderate cost by accurate measurements of pressures, differential pressures, and drafts at various points in boiler settings.

Meriam Draft Gauges are unfailing in their accuracy because they operate on the basic, unvarying laws of gravity and differential pressure. They have no moving parts to wear out.

Moreover, users report years of trouble-free service, from these durably constructed gauges. Aluminum body, dust proof case; and gland packing prevents leakage.

Meriam Draft Gauges are convenient, too: The adjustable mounting bracket insures easy leveling. For periodic checking, the plunger unit offers a quick zero adjustment. Amplified scale range permits easier reading, and the large plate glass cover provides excellent visibility.

In addition to the single tube illustrated, Meriam Draft Gauges are available in two tube and three tube styles. Consult Meriam Engineers about your problem. Write for Bulletin No. 4.

THE MERIAM CO.
Instruments for Indicating Pressure or Flow of Liquids and Gases
CLEVELAND • OHIO
Representatives in Principal Cities

Instruments
THE MAGAZINE OF Measurement and Control

Vol. 14 **FEBRUARY 1941** No. 2

FRONT COVER: Central-station heat-treating room of Reece Buttonhole Machine Co., Boston. Temperature and time controllers, load indicators, etc.
Courtesy C. J. Tagliabue Mfg. Co.

EDITORIAL COMMENT 29
Education and Training Crisis

NEW INSTRUMENTS 31
Indicators, recorders, controllers, inspection devices, etc., for plant, field and laboratory

MICROMANOMETER 37
with illuminated pointers
By Francis C. Morey

AUTOMATIC BALANCE RESTORER 39
using contacts and Thyratrons
By S. P. Sashoff and W. K. Roberts

CALIBRATION ARITHMETIC 40
for both discrete and continuous scales
By Ellis Blade

EDUCATION AND TRAINING 42
A new department. Survey by Richard Rimbach: news of courses at Case, Pitt and Illinois Tech

INSTRUMENTS' BOOK SHELF 44

MISCELLANEOUS ITEMS 50

MANUFACTURERS' NEW LITERATURE A5

ADVERTISERS' INDEX A6

Published Monthly on the 15th by
THE INSTRUMENTS PUBLISHING COMPANY
1117 Wolfendale Street, Pittsburgh, Pa.

RICHARD RIMBACH, Managing Editor — **M. F. BEHAR**, Editor

BRANCH OFFICES
Boston: James Condon, 36 Myrtle St. (Lafayette 0829).
New York: R. K. Farnham, 56 W. 45th St. Room 1105 (Murray Hill 2-8763)
Chicago: William Farnham, 201 N. Wells St. (Andover 4180).
Cincinnati: Harold W. Haskett, Keith Bldg. (Parkway 7639).

Annual Subscription: U. S. $2.00. All other countries $3.00 *payable in advance* (remit by New York draft).

Copyright 1941 by The Instruments Publishing Company.

Entered as second-class matter January 2[illegible] 1932, at the post office at Pittsburgh under the Act of March 3, 1879.

NOT 1 BUT 5 . . . THAT'S THE STORY! NOT 1 BUT 5!

See why the NEW TAYLOR FULSCOPE CONTROLLER *is called the "Not 1 but 5" instrument*

YOU *will* see as soon as you install the New Taylor Fulscope Controller. It grows with its job. And just what does that mean? Simply this: if you install the simplest form of the new Fulscope Controller, and ever want to change the instrument into a more advanced controller, capable of caring for more complicated processing, you can have it done with the *same* instrument . . . you don't need to buy another controller. Here's how it works:

All Fulscope Controller cases are completely drilled and tapped. Adding or substituting other unit assemblies to the basic Fulscope Controller you may have, converts the instrument into a *different* controller. You started out, say, with a fixed high sensitivity controller. Now you need a controller with adjustable sensitivity and automatic reset (in the same case.) You may have this unit assembly substituted, *in the same case*. There's your *new* instrument.

Notice the five forms of control (detailed below) that are available in the New Taylor Fulscope Controller. And remember this: whatever type of process control you demand—from the very simple to the greatly advanced—you can get it with the Fulscope. It's a completely redesigned, *new* instrument, created for modern industry's top-speed preparedness needs.

Ask the Taylor man about the New Taylor Fulscope, and the new Taylor Recorder. Or write Taylor Instrument Companies, Rochester, N. Y. Plant also in Toronto, Canada.

Not 1, but all these 5 Forms of Control Available in the NEW TAYLOR FULSCOPE CONTROLLER

Fixed High Sensitivity—Adjustable Sensitivity—Adjustable Sensitivity with Automatic Reset (in same case)—Adjustable Sensitivity with Taylor's unique Pre-Act effect Adjustable Sensitivity with Automatic Reset and Pre-Act

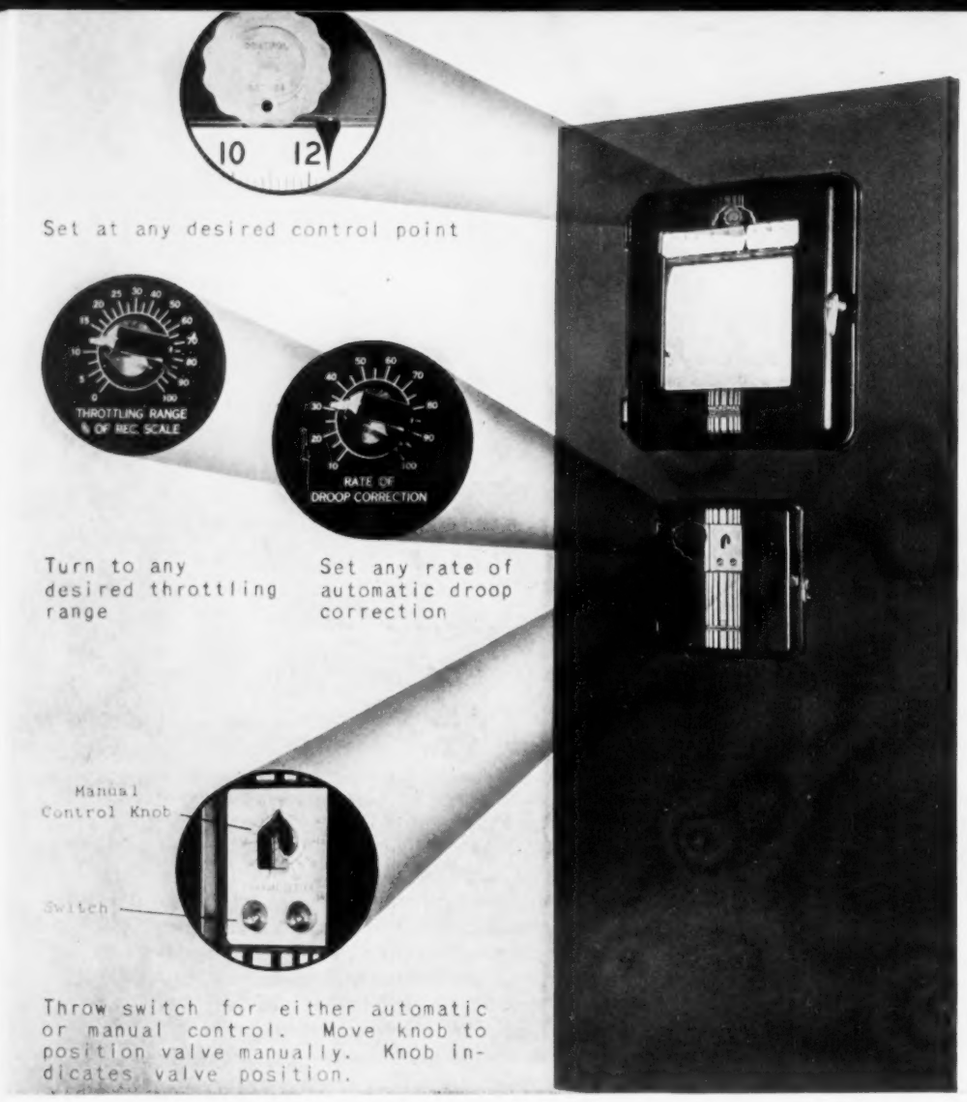
All Fulscope Controller cases are drilled and tapped to permit adding or substituting different forms of control—easily, right in the field!

BE PREPARED with TAYLOR INSTRUMENTS

Taylor

Indicating Recording Controlling

TEMPERATURE, PRESSURE, FLOW *and* **LEVEL INSTRUMENTS**


10 12
Set at any desired control point
THROTTLING RANGE % OF REC. SCALE
RATE OF DROOP CORRECTION
Turn to any desired throttling range
Set any rate of automatic droop correction
Manual Control Knob
Switch
Throw switch for either automatic or manual control. Move knob to position valve manually. Knob indicates valve position.

Micromax is easily tuned to the furnace's needs—all settings are made at the front of the panel.

THERE'S NOTHING TO ADD

To Your Micromax Control Pyrometer

Every setting and resetting that any pyrometric control could use on any standard type fuel-fired industrial furnace is supplied with the Micromax Controller.

We don't even have to know how much load-swing you anticipate, or how much lag; many users do send us these facts, but every Micromax Controller is completely adjustable to any such problem . . . The limits of satisfactory control, if there are limits, being determined by the other equipment and not by the Pyrometer.

Just tell us, when you specify Micromax, the valve, fuel, type of couple and range of calibration. The resulting instrument will help you secure control of unsurpassed sensitivity, accuracy and dependability. It can, if you wish, be shipped completely wired on a panel, ready to install.

For details, see Catalog N-OOA.

Jrl Ad ENT-0600A (2)

Metallurgist Tells How He Records Rate of Cooling When Steel Is Quenched

In making practical use of the "hardenability" factor of various steels, research metallurgists now secure an automatically-drawn record of the rate at which a steel part cools when quenched. And, furthermore, they can record the rate of cooling at any one location on an article, as for instance at the root of a gear tooth.

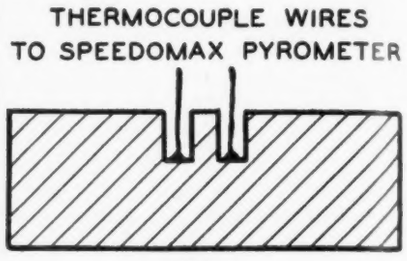
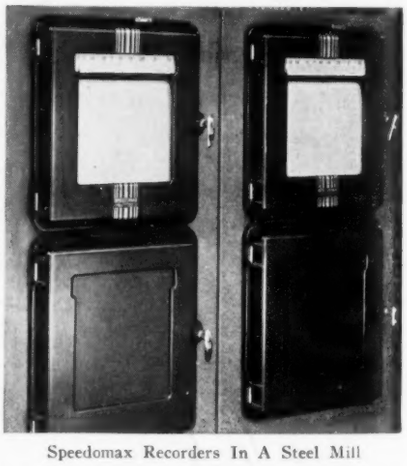


FIG. 1

The method of measurement, referred to by Walter E. Jominy on page 686 of "Metal Progress" for November 1940, seems widely applicable to temperature-measuring problems. Two 0.052-inch holes are drilled $\frac{1}{32}$ inch apart, in the work to be measured. (See Fig. 1). An iron thermocouple wire of 0.025-inch diameter is welded to the bottom of one hole, and a constantan wire to the other, and the small space remaining in each hole is packed with a high-temperature cement. The wires are run to a Speedomax high-speed recorder, leaving, of course, sufficient slack for the part to be handled in heating and quenching.



Speedomax Recorders In A Steel Mill

Being so close together, the two wires stay at identical temperatures, and therefore function as a thermocouple, just as they would if welded to each other instead of to the gear. And the Speedomax is so fast that it records the changes in the couple's temperature, even when it is plunging downward at 70 degrees or more per second during the quench. The slowing of the cooling rate, as the temperature goes down, is shown with especial clearness.

Speedomax is described in Bulletin N-33B-685(1), sent on request. In writing, please outline your problem, since Speedomax is capable of many applications.

LEEDS & NORTHRUP COMPANY, 4955 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

Fast-growing Need for Education and Training and what *Instruments* Is Doing

JUDGING from the trend of recent letters, it will not be long before a majority of *Instruments'* subscribers are actively engaged in educating or training instrument men (and women) or at least in supervising such training. It has become a physical impossibility for your editor and the staff of *Instruments* to reply fully to all inquiries on details of educational courses and training courses.

Don't infer, however, that *Instruments* is discontinuing its free information service. On the contrary, we're expanding it!

Here is the situation:

Questions pertaining to instrument education in classrooms and laboratories — recommended outlines, bibliographical references, etc., can be handled with relative ease. This is particularly true of the at-last-recognized subject known as "Instrumentation." It so happens (away, false modesty!) that this is your editor's creation: seventeen years ago I alone conceived it as a distinct branch of engineering and I alone proceeded to formulate its elements. It so happens, furthermore, that *Instruments* is the only magazine to have published serially the only treatise on the theory and application of industrial instruments: my Manual of Instrumentation. Almost anyone in this office, therefore, can immediately cite the Parts, or chapters, or sections, of this Manual to be used as references for various parts of Instrumentation courses. Most are out of print—unavailable for general distribution to students at this moment—but all are accessible in most technical libraries.*

Similarly, our staff can send prompt replies to most inquiries on immediately-available special texts on specific topics such as spectrography, geophysics, flowmeters, shop measurements, etc. This office keeps track of hundreds of useful books put out by other publishers and by some of the larger manufacturers of instruments, meters, etc.

In addition, the president of the Instruments Publishing Co. has been conducting a detailed survey of general and special instrument courses offered by engineering schools and has prepared a systematic tabulation in order that each engineering professor may know at a glance what all his colleagues are doing—the aim being to facilitate exchanges of experiences, etc., and multiply successful courses, (See pages 42-43.)

Where a "bottleneck" exists is not so much in education as in training, specifically in training that requires individual coaching at the workbench. The Instruments Publishing Co. cannot promise to give detailed advice to those who seek to impart special skills. This Company cannot undertake to compile the details of highly-specialized training courses for men and girls who are to clean, adjust and maintain various specific types of instruments. This generally includes practical and personal instruction in manipulations. It combines intimate knowledge of tiny pivots, springs, spindles, etc., with effective use of the muscles of the wrist and of the hand. The instructor must have had not only book knowledge but actual practice. Nevertheless, books are needed because no instructor can rely on his memory.

Nearly three years ago, anticipating the emergency in which this Nation now finds itself, we made various tentative plans for modifying *Instruments'* service accordingly. With regard to education, no change was necessary: we simply continued to formulate Instrumentation courses and to preach their adoption. With regard to training, however, our plans depended upon the availability of experienced specialists able to give time to the various projects. For example the chief project pertaining to the training requirements we foresaw—the formulation of a book on the care and maintenance of instruments — had to be slightly modified because, among prospective authors, the most promising turned out to be one in the employ of an electrical-instrument firm—an inexperienced writer but one who had specialized in the care and maintenance of electrical instruments and was teaching this subject in a Vocational School. Therefore, we signed up this competent author. After he had written the first thirty-odd pages and shown them to us, we recommended that he generalize and broaden his treatment. He has been preparing his text in line with our suggestions — suggestions

*Part Two, "Temperature Measurement and Control," is nearly all re-written and the new edition will probably be out in April. Part Seven, "Electrical Measurements and Control" (of which Perry A. Borden is the priceless co-author) will follow shortly thereafter. Then will come a reprint of Part Three, "Humidity Measurement and Control."

based on *your* needs; and this widely-useful text will soon begin to appear serially in *Instruments*. Its serial publication will probably be completed by next winter and the Instruments Publishing Co. will then bring it out in book form.

But what of the hundreds of readers who are giving training, who possess some skill but not enough special knowledge to impart that skill, who therefore *immediately* need texts on care and maintenance of fine instruments?

One excellent substitute for the ideal general text is: *any book on watchmaking.* (We regret that circumstances beyond our control prevent our listing at this time the available ones, including some special issues of horological magazines. This may be possible in our next issue, we hope.)

Another excellent substitute for a generalized care-and-maintenance manual is a book which has just reached our desk, though dated 1940:

> **Handbook of Airplane Instruments,** KOLLSMAN INSTRUMENT DIVISION, SQUARE D CO., Elmhurst, N. Y., 1940. Leather ring binder, 8½ × 11 inches, approximately 150 pages (most sheets printed on both sides). Price $2.00.

We recommend that this book be purchased and studied by all who are in charge of training instrument maintenance men and women, regardless of the types of instruments to be serviced. One reason is that it begins with a section on General Directions, arranged as follows:

The Workroom	Broken Jewels
Tools	Worn-out Pivot Holes
Testing Apparatus	Worn-out Pivots
for Low Temperature	Rusty Pinion Teeth
for Vibration	Worn-out Gear Teeth
General	Wheels Out of True
Before Taking Apart	Moving Parts Out of Balance
Too Much Play	Dented Diaphragms
Bent Parts	Radium Painting
Broken Pivots	Cases, Glasses and Other Parts
Bent Hand-staffs	Taking Out Tight Glasses
Side Play	Cleaning
Corrosion	Shipping

The rest of the book is devoted to the various altimeters, tachometers, manifold pressure gages, etc. In each section, there is a full-page (6″ × 8″) perspective drawing of the instrument mechanism. These are masterpieces! They show up details as well as do the beautiful wall charts put out by Weston, General Electric, Spencer Lens, and other instrument companies — perhaps better, because they are large-scale drawings like those on the wall charts, but reproduced in a book so that they can be studied in comfort.

The instructions for dismounting, cleaning, adjusting and reassembling the instruments are among the most detailed and certainly the most profusely illustrated that we have ever seen. Almost every step is not only explained in words but by means of a 3″-wide drawing. Some of these drawings are composite: showing not only the position of the fingers, tool and mechanism, but a close-up (as would be seen through a magnifying glass) of the particular manipulation involved.

On page after page, it is obvious that the authors have had experience in training boks and girls. Nothing is left to the memory of the student. Little bits of advice are repeated again and again, as are references to General Directions in the front of the book, and to Technical Notes in the back.

We noticed that the language is extremely simple. Here and there we were wondering why the sentence construction was so primer-like. But when we came to the last page we saw the explanation: Much of it is written in Basic English! Since Basic English does not include the many special words that had to be used, a glossary of these words is included. Thus this Handbook will no doubt have a well-deserved vogue throughout Latin America.

Large type is used not only for the main text matter but for tables, incidental notes, etc.

When ordering a copy of this book from the Kollsman people, be sure to include the name of an individual in addition to the name of your school or company, because free supplementary sheets will be put out from time to time.

[Aside to authors: Use this book as a model for *yours* on servicing the instruments *you* know—then submit your MS to this company. But first write us to ascertain whether your particular field is promising.]

The foregoing enthusiastic endorsement of this book is dictated by purely patriotic motives. The Instruments Publishing Co. cannot collect the usual publisher-to-publisher discount because the Kollsman Div. is not a publishing company. And this "starring" may cut down the future sale of the maintenance book to be published by *this* company! But good Americans think first of abolishing bottlenecks, these days. If the O.P.M. or other Federal agency took over the now private-enterprise compilation of instrument care-and-maintenance manuals in order to speed it up (and if such speeding-up were a certainty) we'd "fall in" like good soldiers. So we say to the Kollsman people: "Congrats on beating us to it!"

By the way, has anyone else beaten this Company to it? If there is any other care-and-maintenance book, as *generally* useful as the Kollsman one, we'd like to be advised, so that we may give it a free write-up. Condition: the company or institution that puts it out must have several hundred copies immediately available.

We cannot conclude without reminding old subscribers (and notifying new ones) that brief general outlines on the practical training of instrument men in industry may be found in the files of *Instruments* in company libraries or public libraries. Here are some articles:

Roy Brown. The Plant Instrument Department. Vol. 5, Feb. 1932.

G. P. Bosomworth. Selecting and Training Plant Instrument Men. Vol. 8, Nov. 1935.

(Photographs showing instrument-company training courses.) Vol. 8, Nov. 1935.

R. C. Kennan. Training Instrument Men Where Instruments Are Made. Vol. 9, April 1936.

A. G. Moon. Organizing the Plant Instrument Services. Vol. 9, Dec. 1936.

A. G. Moon. Training Your Own Instrument Men. Vol. 10, Jan. 1937. (Gives detailed schedules, includes pictures and explanations of forms, etc.)

C. B. Cochran. Industrial Instruments Course at the Charleston (W. Va.) Evening Trade School. Vol. 12, April 1939. (Concludes with a list of twenty-two reference works.)

THE MONTH'S NEW INSTRUMENTS

In this department we strive to report each month ALL the new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions. When writing to manufacturers directly, please mention this department as your source of information. Or write to Information Section, Instruments Publishing Company.

Portable Potentiometer for Pyrometry, etc.

New "No. 8667" potentiometer is for thermocouple temperature measurements, for checking thermocouples, or for measuring small emf's. Additional precision is said to be obtained without increase in instrument cost, by sacrificing the convenience of a reference-junction compensator. Accuracy to ±0.1 millivolt has been achieved by calibrating only a small portion of the range

on a continuously adjustable slidewire; the remainder, adjustable in fixed steps, is on a dial switch of ten resistors. Range is from 0 to 111 millivolts with a limit of error of ±0.1 millivolt. New indicator is completely self-contained. No additional accessories are required except the thermocouple and an ice bath for the reference-junction. Built into potentiometer are coarse and fine battery rheostats, pointer galvanometer, standard cell, battery, galvanometer key and standardizing key. Oak case is 12¼" × 7¾" × 7⅞"—*Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa.*

"White-delay" C-r-o. or Television Screen

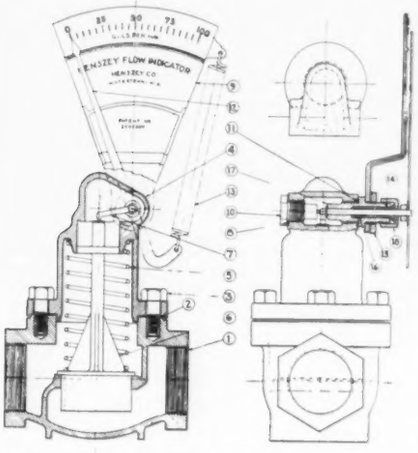
Of interest in cathode-ray oscilloscope work are newly-announced refinements and improvements of the Du Mont delay-screen television tube: correcting the color from the original orange to a satisfactory white. New white-delay tube makes feasible the halving of the usual 30 frames per second to 15, thereby permitting 625-line scanning for greater pictorial detail instead of the 441-line R.M.A. standard, within allotted television channels.—*Allen B. DuMont Labs., Inc., 2 Main Ave., Passaic, N. J.*

High-speed Electronic Counter

Counting at rates up to 2000 per minute is possible with newly designed "No. 475" electronic counter, which multiplies by five the count on the register. In other words, the registered count increases by one for every five objects counted. Thus if the register is mechanically capable of counting 400 per minute, 2000 per minute may be counted. What is said to be the outstanding features of this instrument is that no minimum count per minute is required. It will follow all variations in the speed of the supply. It operates from 110-120 volt 60-cycle supply.—*Shallcross Mfg. Company, 10 Jackson Ave., Collingdale, Pa.*

Flow Indicators

Available in seven sizes up to 4" std. pipe, and up to 600 g.p.m. max. flow rate, new Henszey Flow Indicator utilizes variable-area principle, registers from zero flow to full capacity on a uniformly-graduated scale, is made up entirely of interchangeable parts. It was developed originally for such applications as indicating flow-rate of



1. BODY
2. GASKET
3. CAP SCREW
4. BONNET
5. COMPRESSION SPRING
6. PLUNGER
7. INDICATOR LEVER
8. GASKET
9. DIAL
10. SPECIAL SLT SCREW
11. GASKET
12. POINTER
13. TENSION SPRING
14. STUFFING BOX GLAND
15. HEX NUT
16. STUFFING BOX PACKING
17. STUFFING BOX
18. STUFFING BOX NUT

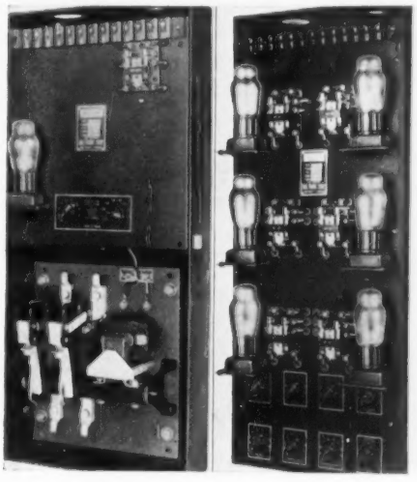
hot dirty blowdown from steam boilers, but is recommended for other liquids such as gasoline, milk, chemicals, etc., where tolerance is 3% of absolute accuracy but where this limit of error must not be exceeded even where indicator is exposed to rough service for long periods without attention. —*Henszey Co., Watertown, Wis.*

Immersion Type Heater

Mechanically and chemically protected by copper, stainless steel or other metallic sheath, and electrically and thermally by fibre-glass insulation, new "Glasohm" armored flexible immersion heating element is said to be a "radically new" type which "can be fitted into any space and for any service and can be made up to meet any particular requirements." It comprises a fibre-glass core for the resistance-wire winding, covered by a fibre-glass braiding and then encased in a seamless metal tube drawn down tightly over the heating element proper. Element is ¼" in diameter, and is available in practically any length. Metallic tubing can be of any metal or alloy to meet corrosion-resistance requirements. Element will operate at temperatures up to 1000°F. Any type terminals are available, such as flexible leads, lugs, binding posts, fittings or plugs. Without the metal jacket, the Glasohm element may be used for non-immersion applications such as electric marking pencils, small soldering irons, etc., where the flexible nature of the glass-insulated element permits it to be used in close contact with parts to be heated. *Clarostat Mfg. Co., Inc., 285-7 North Sixth St., Brooklyn, N. Y.*

Automatic Time Controllers for Welding

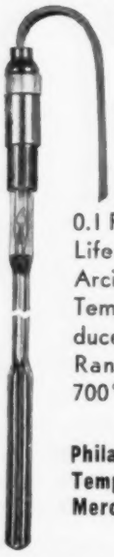
Two new welding-operation controllers are announced. (1) New "Model 108-53 Timer-Contactor" (left-hand illustration) is for use with any 15- to 35-kva. manually- or mechanically-timed spot welder. Available for 220-, 440- or 550-volt welding volt-



tages and for 25-, 40-, 50- or 60-cycle frequencies, new unit is adjustable over a range of timing from 2 to 30 cycles. Two control knobs provide for close adjustment to suit the work being welded. Long life and low maintenance costs are claimed for new controller. A specially designed high-speed, heavy duty welding contactor is employed. Contacts of both contactor and relay are quickly removable for replacement. Entire unit can be serviced without specially skilled help; can be quickly installed by any electrician. Unit consists of an electronic tube, relay and magnetic contactor enclosed in a spring hinge cover case which measures approx. 11" × 13" × 30" and permits mounting either on the welder itself or on a wall or stand nearby.

(2) New "Model 79 Weltronic Welding Timer" (right-hand illustration) is of electronic type, designed for the recently-announced process of resistance forge welding which permits the spot welding of heavy iron and steel sections and which requires a complicated sequence of accurately timed operations. This unit provides timing control for the various operating sequences required for the process, which are: low weld current; high weld current; initial (low) welding pressure; impact forging (high) pressure; cool time; hold time; etc. In addition, new timer is designed to time virtually any combination of functions required in spot welding heavy sections within scope of resistance forge welding process and can be used with any equipment capable of handling such work, whether standard or special. New unit's automatic operation eliminates necessity for skill, even though fabrication of heavy sections is required at speeds which compare favorably with those of sheet-metal spot welding. Eight rapid selective type control knobs permit welding supervisor to "dial" for proper intervals of pressure and welding current, interruptions of both, and for proper cool time following completion of actual welding. All operating elements of the Weltronic Timer—electronic tubes, relays, etc., are mounted on a panel and enclosed in a cabinet to permit mounting on either the welding machine or a separate stand.—*Weltronic Corp., 2832 East Grand Blvd., Detroit, Mich.*

Philadelphia Merc-to-Merc Thermo-Regulators Feature



Mercury to Mercury Contacts : Increased Contact Capacity : Sensitivity within 0.1 F. Exceptionally Long Life and Stability : No Arcing : No Oxidation : Temperature Lag Reduced : Temperature Ranges adjustable to 700°F.

●

Philadelphia Merc-to-Merc Temperature Controls and Mercury Plunger Relays

●

The Philadelphia Thermometer Co.
915 Filbert Street -:- Philadelphia
WRITE FOR CATALOGUE No. 104.
Oldest Thermometer Manufacturer in Philadelphia

HARDNESS TESTING...

done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 33 years.

In general use for specification purposes. Simple, sturdy. Comparatively inexpensive.

Illustrated bulletins free.

The Shore Instrument & Mfg. Co., Inc.
9025 Van Wyck Avenue, Jamaica, N. Y.

SMALL DRILLS

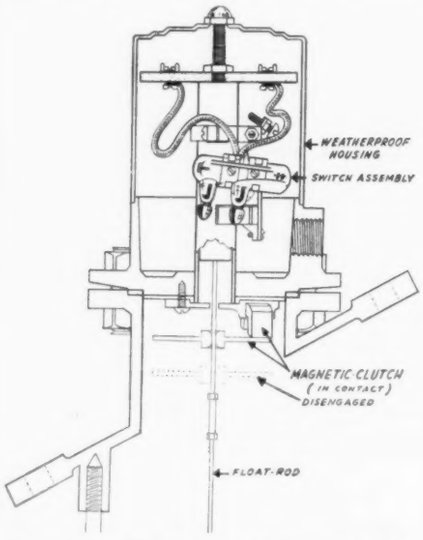
from .0016 up to .1969 inch diameter, all sorts of small turned parts. Small wood screws in brass, steel, etc., turned from the bar.

BLACK GRINDING DISCS

H. C. M. ENGEL, Inc.
P. O. BOX 233, SIDNEY, NEW YORK

Liquid Level Controllers

Announcement is made of additions to "Magnetrol" line of tank float switches. New models include five sizes of "TF-5" designed for flange type tank-side mounting and four



sizes of "TF-6" designed for screw-in tank-side mounting. Each size has a three-to-one range of adjustable differential. Illustration shows "TF-1" for tank-top mounting, with unusually large adjustability of differential (¾" min. diff. and 36" max. diff.). New models feature mercury-to-mercury contact switches and permit field choice of make or break at either high or low level.—*Fred H. Schaub Engineering Co., 325 W. Huron St., Chicago, Ill.*

Dust- and Moisture-proof Interval Timer

New "Model D2" Interval Timer is for control of industrial equipment such as dough mixers, tumbling barrels, heat treating furnaces, laundry machines, etc., in

which timers may be subjected to excessive moisture and dust conditions. Maker's standard self-starting synchronous-motor-driven Interval Timer is enclosed in an especially built cast aluminum housing arranged for conduit connection and provided with a full vision window and external setting knob. Front view bull's eye light signals can be supplied. Timers are available in twelve scales, from one rev. in 15 sec. to one rev. in 24 hrs. Non-clouding type window of unbreakable material is recessed and gasketed to provide dust-tight and splash-proof enclosure. Slight inward pressure on knob assembly engages a clutch for setting the Model D Timer. When released, a spring and gasket prevent entrance of moisture around the control shaft.—*The R. W. Cramer Co., Inc., Centerbrook, Conn.*

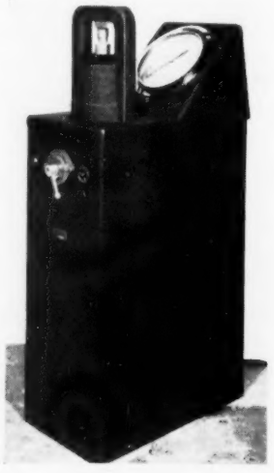
Limit Bridge

New "No. 623 Limit Bridge" is a Wheatstone bridge arranged for rapid production resistance testing. By means of a plug and socket arrangement it provides a selection

of percentages, namely: ± 1%, 5%, 10%, 15%, or 20%. Instrument has a self-contained variable standard and ratio arms. Rheostat or working standard consists of three decades totaling 11,100 ohms and ratio has three multipliers: 1, 10 and 100. Range of resistance that may be tested is from 10 to 1,110,000 ohms.—*Shallcross Mfg Co., 10 Jackson Ave., Collingdale, Pa.*

Specimen Briquetting Press

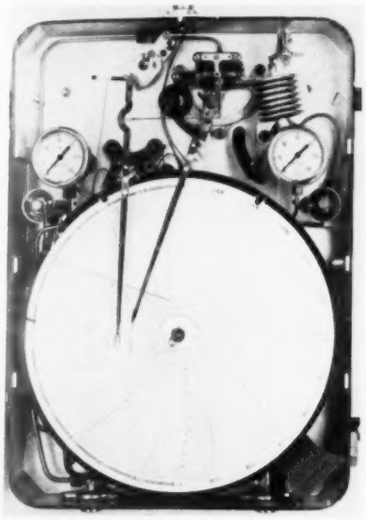
Purpose of new Specimen Briquetting Press is to briquette metal chips and other powdered and granular materials into tablets, which then are placed in spark or arc



gap of spectrograph. Machine consists primarily of a hydraulic pressure system and a press containing mold to form tablet. Heavy-duty hydraulic pump is direct-connected to ¾ h.p. motor. Base of machine contains a 10-gal. oil reservoir. Automatic pressure regulation permits all tablets to be briquetted with the same pressure. Load is indicated on a 10" diam. gage. Pressure may also be manually controlled (by-pass valve) so that setting of regulator need not be disturbed should operator have a few samples of material to briquette that require an odd pressure. Mold is 1" deep, ¼" I.D., takes a 1-g. Sample top of mold is funnel-shaped to facilitate filling. C. I. and steel samples and other hard materials are briquetted under a 15,000-lb. load; soft materials such as aluminum and die-cast metals at loads as low as 4,000 lbs. Tablet is ¼" in diam., recommended length ¼". Accuracy of spectrochemical analysis is equal to that obtained with cast pencil specimens. A special test drill is available for forming small chip samples of ductile materials.—*Harry W. Dietert Co., 9330 Roselawn Ave., Detroit, Mich.*

Adjustable-mode Type of Temperature Controller

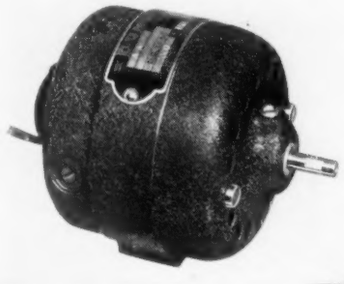
A new throttling-type air-operated temperature controller, "Pre-Set Free-Vane Temperature Controller," is added to Foxboro's line of dragless-prime-relay auto-



matic control instruments. It was developed for use on processes where the thermal characteristics are such that there is a tendency for the temperature to exceed the control setting of the instrument on the initial rise. Examples, batch processes that are started-up and shut-down at frequent intervals and have heating characteristics which cause over-shooting on the starting-up cycle. This is due primarily to slow rate of circulation and resistance to heat transfer, as in a jacketed cooling unit where jacket has appreciable mass and requires considerable cooling medium to arrive at desired temperature. On such processes, new controller introduces a presetting effect proportional to width of throttling range and also rate of change of the condition being measured and controlled. This controller action occurs prior to or during approach of pen to control point. It tends to decelerate the pen and permits asymptotic return of the controlled temperature. Extent and duration of presetting effect may be adjusted "over a wide range" by means of a pointer on an arbitrarily calibrated dial.—*The Bristol Co., Waterbury, Conn.*

Fractional H-p. Motors

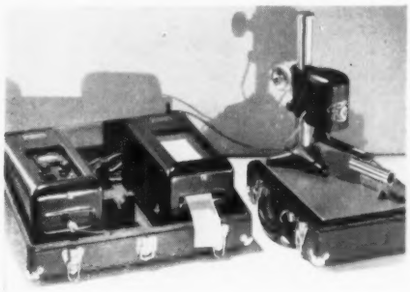
New types "AA" and "A3A" motors with self-aligning bearings (instead of the fixed type sleeve bearings) replace the "A" and "A3" fractional horepower universal mo-



tors. Ball bearings or sleeve bearings may be furnished in the same housing. Oil capacity in bearing bosses has been enlarged, and the "A3A" motor is equipped with a heavier shaft. The AA motor is equipped with larger brushes and its brush plug is flush with the housing to minimize possibility of breakage.—*Dumore Co., Racine, Wis.*

Surface Analyzer

New Surface Analyzer has been designed for determining the surface quality of machined metal parts, paper, glass, plastics, photographic film, etc. It provides an instantaneous and permanent ink-on-paper record of the actual peak to peak values of surface irregularities in millionths of an inch. Chart record also indicates the number of these irregularities within a certain area. Recording is accomplished by the so-called "tracer method" whereby surface



under test is traversed by a fine diamond tracer point, which actuates a piezo-electric crystal element, generating a voltage directly proportional to vertical motion of tracer point. This voltage is then amplified for operating a direct-inking oscillograph. Motion of oscillograph pen is directly proportional to original motion of tracer point magnified as much as 40,000 times. Surface Analyzer is usually furnished in four major units: an analyzer head, an amplifier, a direct-inking oscillograph and surface plate (see photograph). These units are set up in shop or laboratory by connecting to 110-volt 60-cycle power supply. Analyzer head is furnished with a pickup arm having a tracer point of 0.0005" radius. This arm is capable of making accurate measurements of finishes as produced by ordinary production methods where scratch widths are in the order of 0.003" or less. An alternate pickup arm is also available primarily for laboratory measurements when scratch widths are 0.001" or less. Radius of tracer point of this pickup arm may be as small as 0.0001".—*The Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio.*

Illuminator-magnifier

Latest "Magni-Master" is designed for industrial inspection and precision work. Its illumination is said to duplicate daylight conditions, eliminating eye-fatigue. Models

are available in hand units, stand units, or fitted for attachment to special equipment. Each is equipped with ball joint attachments and slides which allow adjustability to any focus or position. 35-mm. achromatic lens is corrected, assuring a flat, sharply-defined view. Power is 4½ ×.—*Mizzy, Inc., 105 E. 16th St., New York City.*

BAILEY METER CONTROL SYSTEM

The Mark of

Effective Control

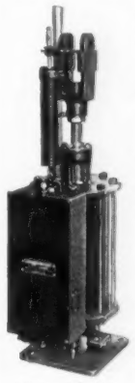
Process Control for sensitive, stable automatic control of temperature, pressure, liquid level, flow and other factors as applied to industrial processes. Responds to changes quickly, without overtravel or hunting. Ask for Bulletin No. 101.

Combustion Control that is simple but *complete* for providing economical operation of boilers of 200 h. p. and larger. Details in Bulletin No. 102.

Recorder-Controller

Boiler Meters for recording combustion conditions and guiding boiler operators. Described in Bulletin No. 44.

Multi-Pointer Gages for indicating factors such as draft, pressure, temperature and speed. These Gages are available with any number of pointers and any scale combination; in either the oil sealed bell or diaphragm construction.



Control Drive

Flow Meters for indicating, recording and integrating the flow of steam, water, sewage, air, gas and other fluids. Bulletins No. 39 and 300.

Recorders for pressure, temperature, drafts, liquid level and other factors.

G-3

BAILEY METER COMPANY

1041 Ivanhoe Rd., Cleveland, Ohio

Multi-range A-c. Ammeter

New "Series J" is a multi-range a-c. ammeter designed for many fields of application, such as radio and electrical appliance, refrigeration, air-conditioning, transmitting, etc. It can be used on all line frequencies

from 25 to 60 cycles; 300 milliamps full scale to 60 amps; eight a-c. ranges; special red correction scale for direct-reading on 25 cycle service; 4⅝" square type indicator; movement has specially constructed damping chamber. Indicator accuracy 2%. When used with maker's Series 844, 854 or 862 multi-range testers, new "J" provides a complete all-purpose ac-dc. industrial type circuit analyzer. Available in 3 models.—*Precision Apparatus Co., 647 Kent Ave., Brooklyn, N. Y.*

Photoelectric Relay

New "CR 7505-K 100" photoelectric relay is housed in a gray cast alloy chassis with a black molded cover which is removable without tools. It will operate at speeds

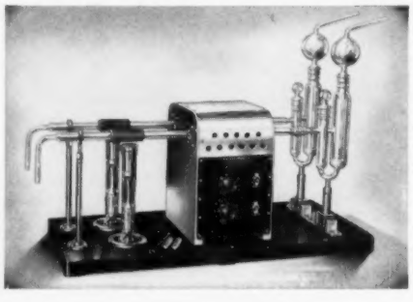
up to 150 interruptions per minute and at a minimum of 40 foot-candles at the phototube with not more than 15 foot-candles of extraneous light present. Relay has a controlled contact rating of 10 amps. at 115 volts a.c., with two normally-open and two normally-closed contacts. Its coil relay is energized when the light at the phototube is reduced below 30 foot-candles. There is provision for mounting the relay by any one of the following methods: wall mounting on concealed rigid conduit, exposed rigid conduit, or with flexible conduit or open wiring; bench or table mounting on rigid conduit, or with flexible conduit or open wiring; and by any other methods which meet accepted rules of practice. A removable bracket can be secured to the supporting surface and the conduit, if used, before mounting the relay.—*General Electric Co., Schenectady, N. Y.*

Elapsed-Time Aviation Clock

New Elapsed Time Aviation Clock combines elapsed-time and second-testing features with standard Kollsman Eight-Day Aviation Clock. An overall dial and large hands indicate time in usual manner. A large sweep-second hand (one rev. in 1 min.) is set in motion by pressing a small button at bottom of clock. A small dial in upper right section of the overall dial serves as the totalizer dial for the sweep-second hand, accumulating the time of this hand up to 0 min. Sweep-second hand and totalizer are stopped by pressing a button. When pressed again, both the second and totalizer hands return to zero. A miniature clock dial, with two conventional hands located in upper left section of the overall dial, registers elapsed time during flight up to 12 hrs. This totalizer is set in motion by pressing the winding knob, and a red dot in the small dial indicates that the minute and hour hands of this special dial are in operation. To allow for time out, the winding knob is pressed again. A silver dot then replaces the red dot, indicating that the hands are stopped. In resuming elapsed time winding knob is pressed again and red dot reappears, indicating that hands are again in motion. On completion of flight, totalizer is stopped by pressing winding knob, while hands of the totalizer dial are returned to zero by pressing another button. New clock's performance at normal and extreme temperatures, and at any stage of winding, meets U. S. Army and Navy specifications. Possibility of stripping under rough treatment is said to be eliminated by arrangement of winding and setting mechanism to insure proper meshing of wheels and pinions. Except for bearing pivots and a few small parts, nonferrous metal is used. Clock may be mounted adjacent to a compass without affecting the latter's action. Clock weighs 7 ounces. Its standard hour and minute hands, numerals and five minute graduations are radium luminous coated, while all other hands and graduations are painted white. Although designated as an eight-day clock, it will run ten days on one "winding."—*Kollsman Instr. Div., Square D Co., 80-08 45th Ave., Elmhurst, Long Island, N. Y.*

Sulphur Determination Apparatus

A new apparatus for sulphur determinations in organic materials employs the quartz tube combustion method: volatilizing a previously-weighed sample in a quartz tube, drawing the gas thus formed through an electric furnace at a high temperature into an absorber containing hydrogen peroxide reagent, and finally titrating. This test is said to have aroused interest because of its speed, accuracy and economy. New equipment is known as the "Braun Shell-Design Sulphur Determination Apparatus." It was especially designed for testing petroleum products but is adaptable to a wide range of organic materials. Apparatus consists essentially of a specially designed quartz tube, electric furnace in which temperatures can be maintained between 900° and 1050° C., by a rheostat mounted on a Bakelite panel facing the operator, suitable absorber and spray trap, combustion boat, high-temperature burner and supporting base. Apparatus is available either as a single or double unit. In the double unit each furnace is completely insulated and individually controlled by its own rheostat and switch. One operator can easily operate a double unit.—*Braun Corp., 2260 East Fifteenth St., Los Angeles, Calif.*



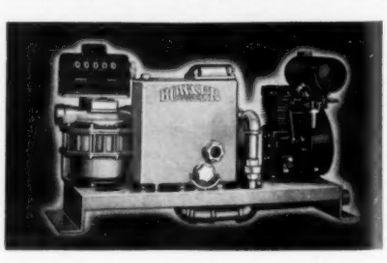
Moisture Tester for Plaster, etc.

"Kaydel Plaster Tester" embodies a moisture-content equivalent reference standard in either of two values. Thus, it can be used by an untrained worker; and its read-

ings are not subject to battery-voltage changes, etc.; nor are any field adjustments required. In use, it is taken out of coat pocket; knob is turned from "off" to "Standard"; dial reading is noted; knob is turned to "Plaster" and pins held against surface to be tested: if reading is not higher than standard, material is dry enough to proceed with job without danger of peeling or discoloration. Batteries are said to last "many months," can be replaced at radio or hardware stores. Instrument dimensions 2⅞" × 1¾" × 5½"; weight 20 oz. Extension contactor (right) with 4½-ft. cable is available as accessory.—*Hart Moisture Gauges, Inc., 126 Liberty St., New York City.*

New Model of "Xactopack"

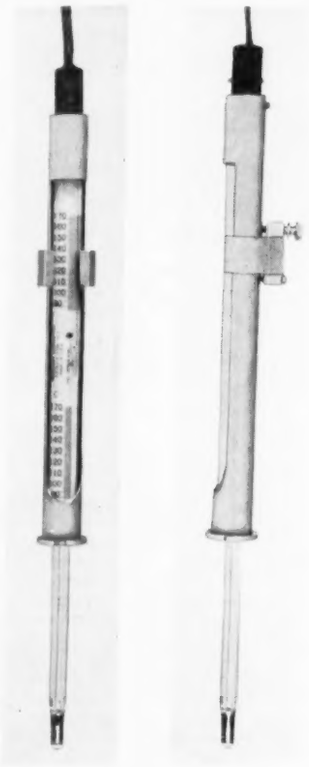
Although illustration received from maker shows gasoline-engine-powered "Xactopack" (see *Instruments*, April 1940, page 95), new model, known as "Figure 385," is available



optionally with explosion-proof electric motor. Other changes are 6" reduction in overall width; and availability in a new large size (40 g.p.m.).—*S. F. Bowser & Co., Inc., Fort Wayne, Indiana.*

Mercurial Thermoregulator

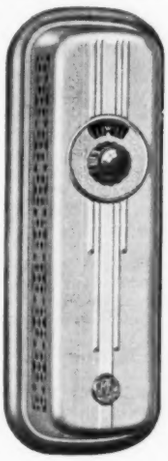
New "Adjustable Contact Thermometer" differs chiefly from usual thermoregulators in that it has two scales: an upper one for close visual setting and a lower one which



is that of mercury thermometer. Setting is made (in a few seconds) by positioning a magnet which in turn positions a glass-covered rod within inner tube. From this rod a thin wire extends down into thermometer proper. Bottom of wire need not be readily visible, because its contacting position is indicated by top edge of rod on upper scale. Wire passes over a contact bridge located between upper and lower scales; other contact is in lower part of thermometer. Guaranteed accuracy, ±0.1°C. Range, 85-175°C. (others to order). Overall length 15"; 4½" stem below sheath. Instrument operates on 110 volts, any commercial frequency, with not more than 10 milliamps. Available from stock is a 5-milliamp., relay for controlling a 220-watt load; other relays available. — *Brabender Corp., Rochelle Park, N. J.*

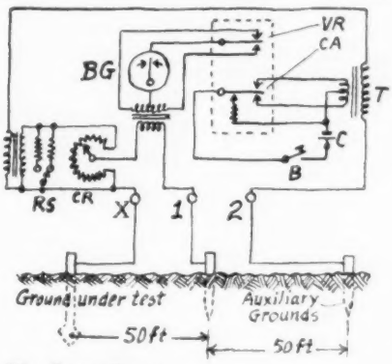
New Model of "Comfortrol"

A new model is announced of the "Comfortrol," a humidity-compensated thermostat incorporating maker's multiple-human-hair element coupled to a bimetallic temperature element in such a way that the point of dry-bulb control is automatically varied to suit the existing relative humidity. See *Instruments*, Sept. 1930, pages 560-563 for underlying principles; May 1934, page 101, for technical description of original "Comfortrol"; also April 1938, page 106. — *Julien P. Friez & Sons, Baltimore, Md.*



Ground Resistance Tester

New "Model 251 Vibroground" is a specific-purpose development by makers of resistance testing equipments previously described in these columns ("Vibro Test," *Instruments*, Oct. 1939, page 271; "Model 201," March 1940, page 64). It is especially designed for testing resistance to earth of ground rods and is of the synchronous self-rectifying type. The "Single Test" method of utilizing this new tester is illustrated in the simplified diagram (which does not show all of the instrument's features).



RS - Range Switch
CR - Calibrated-dial Rheostat
BG - Balancing Galvanometer
B - "Push-to-read" Button
VR - Insulated Synchronous Vibrator Rectifier
CA - Current Alternator
T - Step-up Transformer C - Dry Cell

When "Push-to-read" button is pressed, one pair of vibrator contacts connects dry cell alternately across the halves of the transformer primary, inducing across the secondary a 175-volt a.c. which reaches terminals X and 2 through primary winding of auto-transformer. Voltage across secondary winding—and hence across potentiometer—is proportional to current through primary-winding and through ground connection. Thus a null method is employed by adjusting potentiometer until there is no potential between slider and auxiliary ground No. 1. Measurement of X to ground, therefore, is determined independently of ground resistances at 1 and 2. Design of instrument is such that when balance is effected, true ground resistance can be read directly.—*Associated Research, Inc., 431 S. Dearborn St., Chicago, Ill.*

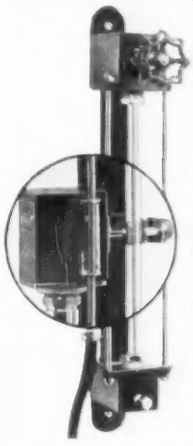
Transmission Photometer

New photometer for application to transmission measurements where small areas are important is designed for such work as quantitative spectrographic analysis, where it eliminates the human element in comparing deensities of spectral lines. Its arrangement allows the operator to see a magnified portion of the field which is being measured. Several apertures are provided in the screen; they may be changed by changing the position of the diaphragm. The slit diaphragm can be rotated to closely align the image of the spectral line with the slit aperature, and there is provision in the diaphragm for any shaped aperture to accommodate special conditions of measurement. After final adjustment, optical parts remain fixed, require no further movement for focusing. Spectral lines are focussed on the screen by moving the plate plane with respect to the objective, so that magnification remains constant. Other features: horizontal plane mounting; vernier adjustment of the plane in the direction of the wavelength axis; focusing by the up-and-down movement of the stage; light control devices located directly in front of operator; and convenient location of the stage, screen, and galvanometer scale, so that the operator can make all adjustments from a single position.—*General Electric Co., Schenectady, N. Y.*

A *New* REMOTE CONTROLLER

. . . . with unlimited possibilities

This controller, which employs the famous "Radio Principle", may be readily adapted to practically any application where control is essential. It can be actuated by any means which will affect the inductance or capacity of its pick-up unit. Photograph at left shows one of the available types of pick-up units applied to liquid level control.

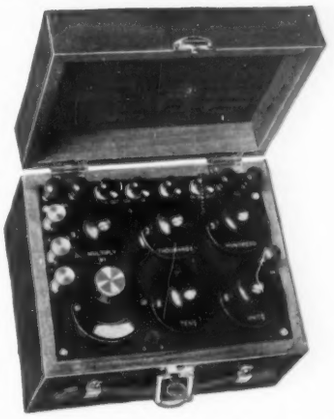


Complete description given in Bulletin J2-2.

Have you entered the Remote Controller Contest? First Prize is $100.00.

Wheelco Instruments Co.
1929-33 S. HALSTED STREET . . . CHICAGO, ILLINOIS

PORTABLE
WHEATSTONE BRIDGE



A high grade instrument for measuring resistances from a fraction of an ohm to 10 megohms. Contains a 4-dial rheostat, ratio dial, galvanometer and battery, all enclosed in a substantial walnut case. Nine coils per dial. Accuracy .1%. Built to endure.

Cat. No. 1050—Portable Wheatstone Bridge with Murray and Varley Loops. . .$110.00
Cat. No. 1052—Portable Wheatstone Bridge without Murray and Varley Loops. $90.00

Send for Bulletin No. 105

RUBICON COMPANY
Electrical Instrument Makers
Ridge Ave. at 35th St. Philadelphia, Pa.

Multiple-reflection Galvanometer

"A new galvanometer, more than three times as sensitive as previous galvanometers" is announced. Announcement lists applications (where wall types were heretofore frequently necessary), describes multi-

ple-reflection arrangement of two fixed mirrors and other mechanical features including external zero adjuster, Alnico magnets, Formex wire, coils, etc. Announcement does not give figures on sensitivity or other electrical characteristics.—*General Electric Co., Schenectady, N. Y.*

Interference Locator

New "Model IL-2 Interference Locator" is said to be an entirely new device, designed in coöperation with public utility engineers and radio interference specialists. It is said to be equally useful to radio servicemen interested in noise complaints, or to public utility engineers, and to municipal wa-

ter and light departments for locating underground pipes. It operates either from self-contained batteries for portable operation, or directly from 115-volt a-c. or d-c. lines. It is equipped with directional loop antenna mounted on top of cabinet when in use or carried within a cover recess when carried. An extensible pole antenna is also provided as standard equipment. Tuning ranges, selected by a switch, are 500 to 1700 kc., 1.7 to 5 Mc., and 15 to 32 Mc. Sensitivity is such that an input signal of less than two microvolts will produce a deflection of 10% on output meter scale. A two-range calibrated output meter provides a visual as well as audible measure of interference intensity. Headphones may be attached in locations where high extraneous noise levels exist. A calibrated volume control may be used with the output meter to measure interference suppression devices. Loop antenna can be switched to audio input as a search coil for a-f. interference pickup or for use as a pipe finder. A special coaxial cable, complete with connectors, is also available at extra cost, for remote use of pole antenna as a probe. Dimensions 15" × 11" × 8"; weight 23 lbs.—*Sprague Products Co., North Adams, Mass.*

Electrical Timers

Diversifying their lines of split-second synchronous-motor, automatic and instantaneous-reset timers, makers announce four series: "M" Series timers are for push-button control, where release of button is required for resetting timer to renew identical timing period upon new impetus. Six standard models. "P" Series timers afford instantaneous and automatic reset, regardless of push button being open or closed, and renew timing period of identical duration upon new impetus. Six standard models. "TD" Series times the period in which

Top left, "A" series; top right, "TD" series; left, "BHR" series.

current is not applied. The first two timers control the "on" period. "TD" controls the "off" period, and is designed for machines requiring a definite warm up period, also, where timed "off" sequence must be accurate. Six standard models. "BHR" Series timers can be used either to announce "on" or "off" timing period, are believed to be the first electrical buzzer or gong signal timers made. Warning lights may also be applied, with or without sound signals, to this timer. All present standard units provide the following:

Time Cycle	*Dial Calibration*
1—14 sec.	¼ sec.
1—28 sec.	½ sec.
1—55 sec.	1 sec.
5 sec.—2 min. 45 sec.	5 sec.
5 sec.—5 min. 30 sec.	5 sec.
15 sec.—14 min.	15 sec.

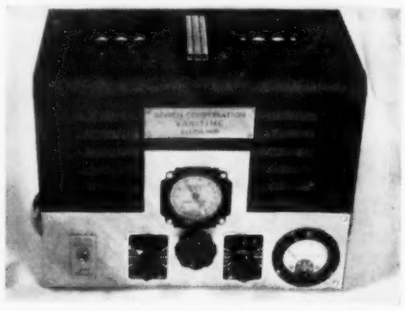
Custom built equipment can be ordered for delivery for timing operations at both ends of the standard equipment ranges. Heavy-duty, self-lubricating motors are incorporated in all models. Units are furnished both in metal cases or un-cased for flush or panel mounting as an integral part of other apparatus. Output contacts (wiring of the timers at the controlled "output" side) are available in varying combinations. —*Industrial Timer Corp., 101 Edison Pl., Newark, N. J.*

Small-volume Air Regulator

Designed especially for laboratory use "Grove Pressure Reducer" is available as either a combination pressure reducer and relief, or simply as a relief valve. "Extreme accuracy, due to enormous valve to diaphragm area ratio," is claimed. Inlet pressure range up to 3000 lbs./in.² and outlet pressure range from ½ to 1000 lbs./in.². In addition to manual setting (by means of a ball-bearing spring handwheel), regulator can be adjusted for a micrometric flat spot or dead range by positioning acorn-nut-encased adjuster on handwheel. Supply pressure may be non-corrosive air or gas from a line, cylinder or container under a pressure greater than the desired maximum delivery pressure. Furnished for flush-inset or surface panel mounting, unit is also available with bracket for installation on a bar or pipe.—*Grove Regulator Co., 1735 Poplar St., Oakland, Calif.*

Variable-frequency A-c. Source

Chief use of new "Soren Varitime" is to vary the speed of synchronous motors used in connection with controls, timing systems, school, hospital and hotel clock systems, etc. It is said that wherever a system of clocks is out of timing this instrument can be adjusted to immediately bring them into syn-



chronism. It is also useful in correcting the speed of synchronous motors and adjusting the mechanism where such motors are used. Specific function of "Soren Varitime" is to supply voltage of a controllable variable frequency. It also supplies power to operate electrical devices: models now available are of 30-watt capacity, other models of different power requirements can be made available. "Varitime" was primarily designed to operate or test synchronous motors, clocks and similar equipment. It provides an adjustable frequency range of 18 to 240 cycles. Weight, 20 lbs.—*The Commonwealth Engineering Co. of Ohio, Dayton, Ohio.*

500-watt Rheostat

Construction of new "F-500" eight-inch, 500-watt rheostat follows that of maker's earlier models, design features being metal-porcelain-vitreous enamel construction; re-

sistance wire or ribbon wound over porcelain core, each turn locked against shifting by vitreous enamel; metal-graphite contact brush with one end of spiral connector integrally molded and other end connected to center terminal; ceramic form mechanically fastened to cast aluminum base independent of enamel or cement. It is said to be particularly well adapted for applications such as motor speed control, generator field control, lamp dimming, electronic tube control, etc. It is available with tapered windings, special shafts, built in off position, tandem assemblies, perforated metal enclosures, etc., in eighteen resistance values from 1.0 to 2500 total ohms.—*Hardwick-Hindle, Inc., 4 Hermon St., Newark, N. J.*

A Micromanometer with Illuminated Water-surface Locators

By FRANCIS C. MOREY

National Bureau of Standards, Washington, D. C.

INTRODUCTION

THE micromanometer described in this article was built as a part of a coöperative research program of the National Bureau of Standards with the Fluid Meters Research Committee of the American Society of Mechanical Engineers, on the discharge coefficients of flow nozzles. An instrument was desired which would be capable of measuring the differential pressure produced by a flow nozzle in a water pipe line at low flows. Over a pressure range of 0.1″ to 10″ of water the accuracy sought was 0.2%. The water used in the pipe line was recirculated, and, although fairly clear, it contained some impurities in solution and suspension. This was considered in the design, since it was desired to avoid frequent cleaning of the instrument. Existing designs were found unsuitable because they employ glass tubes of relatively small diameter in which chemical cleanliness is essential.

The instrument adopted is absolute, involving only the measurement of a length and the density of the water used. It is simple and rugged, although not readily portable. During more than two years' service it has required cleaning only two or three times.

DESCRIPTION

The micromanometer is simply a water-filled, inverted U-tube manometer utilizing pointer gages to locate the water surfaces. The pointers are operated by micrometer screws which measure the vertical distance between the water surfaces.

Two glass cylinders *A* (Fig. 1), approximately 6″ in diameter and 15″ long, are clamped between base plate *B* and caps *C* by means of threaded tie rods, soft rubber gaskets at each end providing a tight seal. Connection of the pressure lines to the cylinders is made through a set of fittings below the base plate. Each cylinder has a shut-off cock *F*, a cross *J* and a drain cock *R*. The pressure lines are connected to crosses *J* by means of nipples which pass through the panel to the back of the instrument. Water flows into the cylinders through the pressure lines until equilibrium is established between the applied pressure, the hydrostatic pressure of the liquid columns and the pressure of the air above the water. The cocks *R* open to the atmosphere to enable the operator to flush out the pressure lines. Valve *K* permits inter-connecting the two cylinders for leveling and for making the zero setting.

The carriage is supported at its ends by two elevator screws *E*, threaded for about one-third their length and fastened rigidly to the base plate. The nuts which operate on these screws to raise or lower the carriage consist of internally-threaded sleeves which are fitted into holes bored in the carriage. The sleeves are rotated by means of gears which mesh with worm gears *G* on crank-shaft *H*.

A slight change in the connections will permit the measurement of gas pressures. The pressure lines are attached at the top in place of the inter-connection, and the compressed air tank is not used. Valve *K* is opened, thus connecting the cylinders at the bottom. One of the drain valves is used to introduce water to the columns, and the other is connected to waste. This enables the operator to control the approximate position of the water surfaces as before.

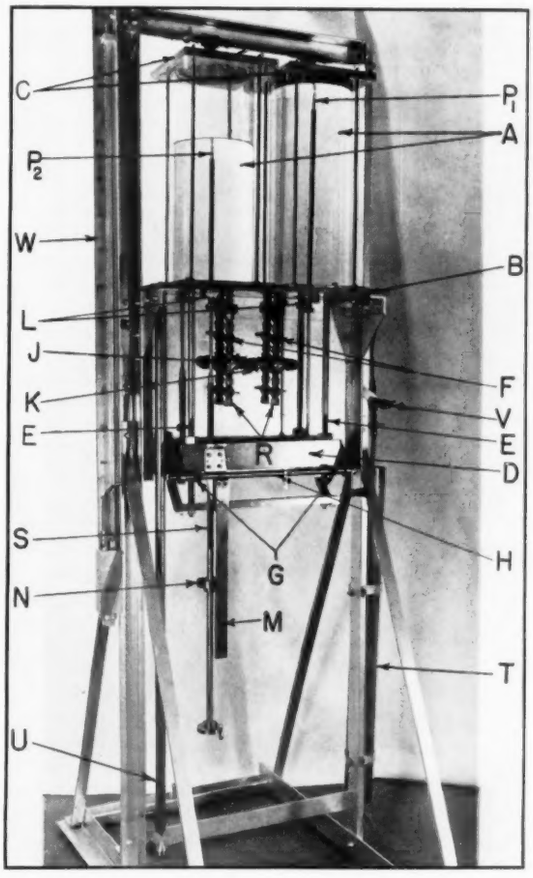


Fig. 1

OPERATION

Before using the manometer it is necessary to level the instrument and make the zero setting. A plumb bob suspended in a metal tube, *U*, is used in conjunction with leveling screws in the base of the supporting framework. The pressure leads are shut off at the source and the cross connection cock *K* and inlet cocks *F* are opened, allowing the water surfaces to come to equilibrium. Differences of temperature of the water in the two columns must be avoided in making the zero setting. It is usually convenient to fill the columns through the pressure leads, taking water from the pipe line to which the manometer is attached. Occasionally this water is at a temperature quite different from that of the air, and sufficient time must be allowed for the apparatus to come to thermal equilibrium before proceeding to adjust the manometer. Similar precautions are necessary in using the manometer after the zero seting has been made, since temperature differences either in the water columns or in the pressure leads may cause errors. Short connections, made as nearly horizontal as possible, help to minimize this source of trouble.

To make the zero setting the micrometer screw is set to read zero. The carriage is then raised slowly, using the elevator crank until contact between the pointer P_2 and the surface is just established. Pointer P_1 is then adjusted by means of the threaded portion which fastens it to the carriage, until contact is made with the water surface. When this adjustment has been correctly made both pointers will contact their respective surfaces at the same time, as the carriage is slowly raised. The instrument is then ready for use.

The manometer is connected so that the higher of the two pressures is applied to the right-hand cylinder. It often is necessary to introduce air from compressed air tank *T* or to allow air to escape through cock *V* so as to keep the right hand surface within the range of travel of the car-

riage and reference pointer. After the liquid columns have become steady, reference pointer P_1 is brought up to touch the surface in the right-hand cylinder, using the elevator crank. Then the micrometer pointer is adjusted to contact the water surface in the left-hand cylinder. The differential height may then be read from the scale and divided head of the micrometer screw.

Proper control of illumination has made possible close setting of the micrometer pointers. The columns are illuminated from behind by four 40-watt frosted bulbs, with a sheet of opal glass interposed between the bulbs and the cylinders. This gives uniform illumination of moderate intensity. Small shields consisting of strips of sheet metal or cardboard are placed between each glass cylinder and its rods at the back, and are held in place by friction. Each shield casts a shadow across the under surface of the water. By raising or lowering the shields the shadows can be made to divide the surface of the water into a dark portion and a light portion as shown diagrammatically in Fig. 2 and in the photograph, Fig. 3.

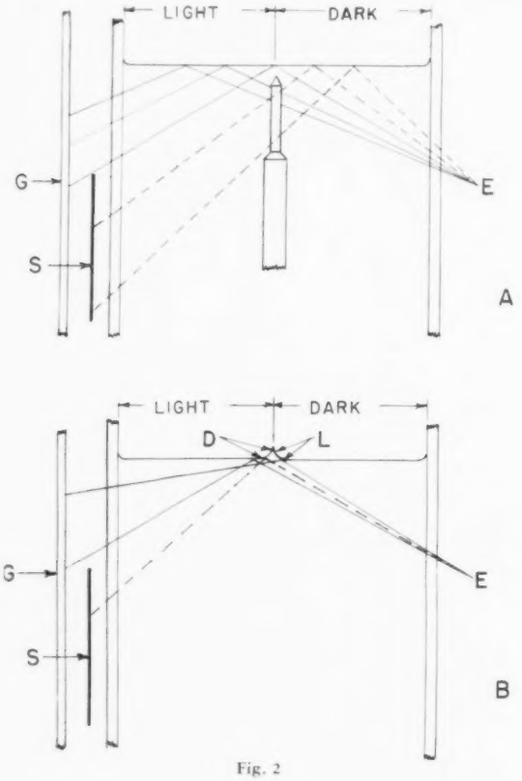


Fig. 2

If the pointer is brought up slowly to the surface and the eye position is shifted so that the point of contact of the pointer with its image occurs just on the line of division between the light and dark fields, a light area will be seen around the point when contact is established. This is due to reflection of light from the curved "dimple" produced in the surface by the pointer. There is also a dark area partially visible behind the pointer in the bright portion of the field. Fig. 2B shows how the dimple produces a light spot L in the dark field, and a dark spot D in the light field. Fig. 3 shows the appearance of the surface with and without contact. Obviously in using the instrument the operator sets the pointer so that the ring of light is as small as possible and yet visible. In the photograph the size of the dimple is greatly exaggerated. The pointer is always brought into contact with the water surface by turning the crank so as to raise the pointer, since lowering it will pull the surface into an inverted dimple due to surface adhesion. This practice also eliminates the effects of any possible backlash in the threads.

Using this method of setting the pointers with a steady liquid column (inlet valve closed) it has been found possible to repeat observations to one-tenth of a division of the micrometer head (i.e. to 0.0001", estimating the last decimal place).

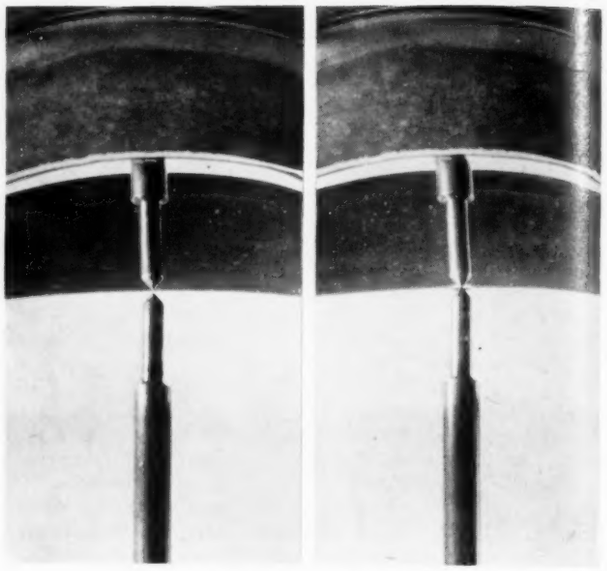


Fig. 3. Appearance before and after contact.

AIR PRESSURE CORRECTION

When using a manometer for precise pressure measurements it is sometimes necessary to make a small correction for the pressure exerted by the unbalanced air column. Fig. 4 is a diagram of a manometer arranged to determine the differential pressure at two points in a liquid. The upper part of the tube is filled with air at a pressure P_3. The pressures P_1 and P_2 whose difference is to be measured are applied at E and F, respectively, and cause the liquid to come to rest h units higher in the right hand tube than in the left. The downward pressure in each tube in the plane AB is P_3. Hence we may neglect the effect of the air above AB.

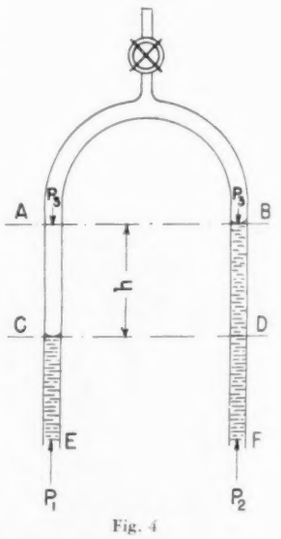


Fig. 4

In the plane CD the downward pressure in the right hand column is $h\rho_e$ and in the left hand is $h\rho_a$ where ρ_e and ρ_a are the densities of the liquid and of the air, respectively. The difference of these pressures must equal the impressed pressure differential; hence we have

$$P_2 - P_1 = h\rho_e - h\rho_a = h\ (\rho_e - \rho_a)$$

If the pressure of the air in the manometer is nearly atmospheric ρ_a will be of the order of 0.001 ρ_e. When using a manometer for measuring the flow of a liquid the static pressure in the pipe line frequently is considerably above atmospheric, and it is therefore necessary to increase the pressure P_3 (and hence the density ρ_a) sufficiently to keep the liquid column on the scale of the manometer. In these cases ρ_a may not be negligible. We may rewrite the above equation in the form

$$P_2 - P_1 = h\rho_e\ [1 - (\rho_a/\rho_e)]$$

The term in brackets now becomes a correction factor to be applied to the observation of h. Although its value will depend upon temperature as well as pressure, for most purposes it is sufficient to assume an average temperature. The mercury manometer W, Fig. 1, was calibrated to read the correction factor directly, from 0.9987 to 0.9973, assuming an average air temperature of 70°F.

SOURCES OF ERRORS

Since the manometer was built with large cylinders so as to have a damping action on rapid pressure pulsations it has a long time lag and cannot be used where the average pressure it not steady over periods of 15 minutes to one-half hour. Especially at small differentials, the time required for the water levels to come to rest may be quite long. To shorten this time the operator may estimate the approximate differential pressure, possibly with the aid of a small auxiliary U-tube manometer, and manipulate the purging cocks and compressed air valves so as to bring the water quickly to the estimated position. A series of observations taken over a period of several minutes is necessary to determine whether equilibrium has been established.

Before assembly the micrometer screw was carefully tested and found to have an average pitch of 0.04998" throughout its range with no deviation from this pitch greater than 1 part in 2500. No serious periodic errors were found. The error introduced in the observations by assuming that the indications of the micrometer head are correct will therefore be less than 0.1%.

The two elevator screws must also be carefully cut and lapped so as to eliminate periodic errors, for any tilting of the carriage as its position changes will cause serious errors.

Automatic Balance-restoring Controller

By STEPHAN P. SASHOFF and WILLMAR K. ROBERTS
Assoc. Prof. Elec. Eng. Research Assistant
University of Florida, Gainesville, Fla.

IN wind tunnel testing of model airplanes the usual procedure is to subject the model to forces similar to those acting on a real plane of the same design in actual flight. The stresses then experienced by the model are measured by connecting certain parts of its structure, through suspension cords or wires, to a series of beam balances.

In connection with the construction of a wind tunnel at the University of Florida, the authors were asked to design a suitable automatic beam balance control. Since the circuit developed can be used in other applications for measurement and control, its description may be of interest to other workers in the instrumentation field. Furthermore, it is quite simple in its operation, stable and exceptionally sensitive.

The mechanical arrangement is briefly as follows: A balance arm made of machined steel is mounted on a fulcrum. One of the wires transmitting a stress from the model plane is fastened to one end of the beam. A weight is then moved automatically until the beam is balanced. By calibrating the position of the moving weight against the stress on the wire, the force on the model plane can be determined at a given point and at a particular instant. The position of the moving weight is controlled by a screw having ten threads to the inch driven by a 1/50 horsepower, split field, 110-volt d-c. motor through a gear reduction of 100 to 1. The motor is mounted on a beam above the fulcrum. In testing, as the stress on the wire is changed, the beam becomes unbalanced and makes contact with one of two fixed stops (see Fig. 1A). When a contact is made an electrical circuit is closed and the motor turns either in forward or backward direction, as the case may be, until balance is established. At this point the circuit is interrupted and the motor stops until an unbalance again occurs. The position of the weight on the balance arm is known from a reading on an indicating device.

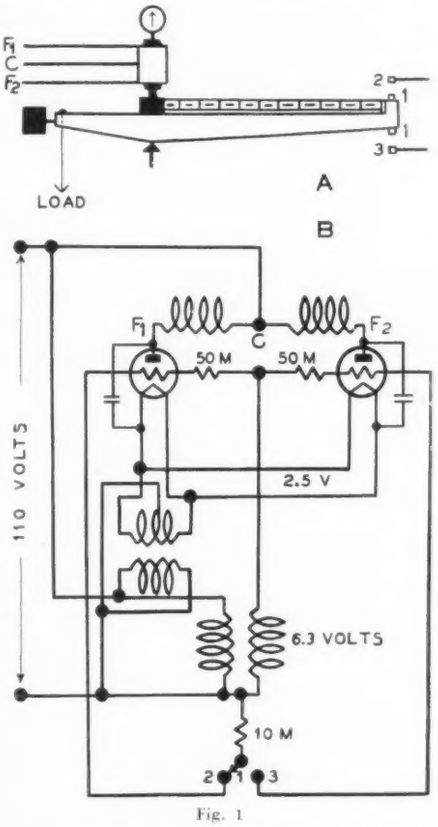


Fig. 1

Fig. 1. (A) Mechanical layout and (B) schematic wiring diagram of automatic beam balance controller. F_1 and F_2 are the two leads to the separate field windings; C is the common lead to the motor; points 1, 2, and 3 are contacts on end of beam. Arrangement is for 110 volts, 60 cycles.

The circuit (Fig. 1B) consists of two Thyratron mercury-vapor grid-controlled rectifiers. One of these tubes when conducting will drive the motor in the forward direction; the other, in reverse. When the beam is balanced neither tube is in operation. As soon as either of the contacts closes, however, the biasing voltage of the corresponding tube is reduced and the tube will start to pass current.

Although the general arrangement of the circuit follows standard practice, it should be noted that because of interaction between the two fields of the motor the circuit may become unstable. Undesired voltages are induced in the idle field and appear on the plate of the tube which is not to operate. In order to prevent this, a capacitor is placed between the plate and cathode of each tube to absorb the sudden voltage surges. The bias necessary to keep the tubes from operating may be obtained from a bias battery. In this arrangement, however, this bias is obtained from a six-volt winding of a small filament transformer.

Another interesting point in this application is that the tubes not only control the direction of the rotation of the motor, but also provide the d-c. driving current by rectifying the a-c. line input. This is important since it obviates the need of a d-c. source.

It may interest some readers to know the current carried by the contacts. For the values indicated on the diagram the contact current is of the order of 20 microamperes. In an application where even this value is too high, the contact current may be reduced at the expense of introducing a three-element high-vacuum tube and a biasing voltage for the same.

In the application described, the motor is running at half rated voltage for the job. In case a higher voltage is needed for the motor, a 220-volt power source must be provided. This may be done by connecting to the 220-volt mains and replacing the filament transformers with others designed for the higher voltage or by supplying the plates of the Thyratrons from a 200-volt secondary of a power transformer of the type used in radio receivers. In the latter case a separate transformer for supplying the filaments and necessary bias voltage is not required, since these can be obtained from the low-voltage windings of the power transformer.

Calibration of Weights, Resistors and Continuous-scale Instruments

By ELLIS BLADE
Department of Chemistry, Columbia University, New York

INDUSTRIAL instrument engineers and calibration-room foremen, as well as physicists, chemists and biologists, may find useful the following procedure, based on the work of T. W. Richards.[1] Originally applied to the calibration of weights,[2,3] the method here described is modified so as to apply also to the standardization of measuring instruments employing a scale: burettes, "Chainomatic" balances, the dial of a spring scale, or the scale of an electrical instrument.

In the first part of the work, the scale is calibrated in terms of an arbitrary measurement unit, while in the second part the temporary values are converted into usable form. Now that international reference standards are readily accessible through the National Bureau of Standards, the magnitude of the final unit will be usually based on a certified standard.

Calibration of a hypothetical set of weights will be used to show the application of the method to a *discrete series*; calibration of a "Chainomatic" balance will serve to exemplify application to all types of *continuous scales*.

[EDITOR'S NOTE—A set of weights is a type example; we therefore added "Resistors" in the title.]

OBSERVATIONS

Let us first consider the case of the commercial weighing series, ½ lb., 1 lb., 2 lbs., 4 lbs., 8 lbs., 16 lbs., 32 lbs. We start with the smallest weight, and assign to it a convenient arbitrary value numerically equal to its face value in millipounds, i. e., 500 units. For the purpose of the calibration, we must have a duplicate of this smallest weight, which we shall symbolize by $\frac{1}{2}A$, meaning auxiliary. The weights of the set itself we will designate by the letter P.

The first step is to compare the weights of $\frac{1}{2}P$ and $\frac{1}{2}A$. Let us suppose the latter is found to weigh 496 units. Knowing the weight, in units, of these two, we compare their combined weight, 996 units, with the next weight of the series, namely $1P$, and find, let us say, this one weighs 990 units. Finally, by successive comparison of each weight with its predecessors, we arrive at a set of self-consistent unit-values for all the weights. This set, for example, might be: 500, 496, 990, 1985, 3990, 7982, 15971, 31939. This completes the first part of the task.

For certain purposes, these values may be used directly for weighing, but in general it will be desirable to follow one of several plans of adjustment. One usually prefers to have the calibration conform to recognized units of measure. But even if this is unnecessary, or perhaps impossible at the particular place and time, adjustment may be resorted to, for simplifying the practical use of the calibration.

Repetition of the above weight comparisons will seldom if ever yield the same set of relative values, because of the accidental errors of the weighings, particularly those in the very beginning of the calibration. If the maximum accidental weighing error is assumed to be 5 millipounds, the maximum divergence of possible sets of values is portrayed in Table I. This divergence need cause no alarm, because each set of values is self-consistent, and except for discrepancies of the same order as the accidental errors, the sets differ only by a constant ratio. In the process of adjustment all such sets reduce to the same one. The reader will find it a useful exercise to adjust the various sets after the manner of Table III, to show their equivalence.

In making the weighings, one should realize the great importance of extremely small differences in the lengths of the balance arms, which may seriously affect the validity of the results unless special precautions are taken.[3,4] Another point is the calibration of the small auxiliary weights used for adjusting the equilibrium to the zero point. For mathematical rigor, these weights should be calibrated in terms of the same units as the large weights, but for practical cases, this consideration may be overlooked, since the corrections are unlikely to be large.[5]

TABLE I—COMPARISON OF POSSIBLE SERIES REPRESENTING THE SAME SET OF WEIGHTS

	1	2	3	4
$32P$	31939	32099	32259	31619
$16P$	15971	16051	16131	15811
$8P$	7982	8022	8062	7902
$4P$	3990	4010	4030	3950
$2P$	1985	1995	2005	1965
$1P$	990	995	1000	980
$\frac{1}{2}A$	496	501	501	491
$\frac{1}{2}P$	500	500	500	500

Column 1: Series given in text.
Column 2: Accidental error of first weighing increased by 5 millipounds.
Column 3: Accidental error of every weighing increased by 5 millipounds.
Column 4: Accidental error of every weighing decreased by 5 millipounds.

TABLE II—CALIBRATION BASED ON THE SUM OF THE CORRECTIONS EQUAL TO ZERO

Denomination	Aliquot fraction	Old-unit value	Old-unit aliquot	Old-unit diff.	Final corr.
ΣP	1	63853	63853	...	...
$32P$	2	31939	31926	13	13
$16P$	4	15971	15963	8	8
$8P$	8	7982	7982	0	0
$4P$	16	3990	3991	− 1	− 1
$2P$	32	1985	1995	−10	−10
$1P$	64	990	998	− 8	− 8
$\frac{1}{2}A$	128	496	499	− 3	− 3
$\frac{1}{2}P$	128	500	499	+ 1	+ 1

TABLE III—CALIBRATION BASED ON CORRECTION OF $32P$ EQUAL TO ZERO

Denomination	Aliquot fraction	Old-unit value	Old-unit aliquot	Old-unit diff.	Final corr.
$32P$	1	31939	31939	...	...
$16P$	2	15971	15970	1	1
$8P$	4	7982	7985	− 3	− 3
$4P$	8	3990	3992	− 2	− 2
$2P$	16	1985	1996	−11	−11
$1P$	32	990	998	− 8	− 8
$\frac{1}{2}A$	64	496	499	− 3	− 3
$\frac{1}{2}P$	64	500	499	+ 1	+ 1

ADJUSTMENT

The kind of adjustment depends upon the use to which the calibration is to be put. Thus, in analytical chemistry, the results are usually expressed directly or indirectly in terms of the ratio of two weighings. In this case it is only necessary that the values of the weights form a self-consistent set, and the only adjustment needed is one that will simplify the subsequent use of the corrections. For example, the sum of the corrections may be made zero. Alternatively, the face value of a certain weight may be adopted as the working value, and all corrections based on this assumption. Or, one might desire to make all corrections positive. In most cases, however, it will be desirable to calibrate in terms of recognized standards, except where it will never be necessary to tie in the figures with the work of others.

It will now be shown how to make the sum of the corrections zero. In the case cited, this condition is fulfilled if the sum of the adjusted values is 64000 units. Since the sum of the old-unit values is 63853, the conversion factor is 64000/63853, or 1.002302. To avoid multiplication in five figures we use the principles of proportion. Writing the denominations of all the weights columnwise in descending order, and their old-unit values with them, we next compute and set down the appropriate aliquots of the sum 63853. (Table II.) Horizontal subtraction of the aliquots from the unit values gives the column of differences. The final corrections are obtained by multiplication of the differences by the conversion ratio, using two significant figures only.

In general the converted differences are not the final

rections, but the corrections to what may be described as the new-unit aliquots. The latter are derived from the standard value of the reference mass. In the present example they are derived from the sum 64000, hence are identical with the nominal or face values. When $32P$ is taken as the reference mass, both sets of aliquots are based on the values of this weight, namely 31939 old units, and 32000 new units. As shown in Table III, the final corrections are again identical with the new-unit differences.

The method of converting any self-consistent series into terms of international standards is that already described, except for the inclusion of the standard reference mass in the original calibration. In the interest of accuracy the standard should be comparable in magnitude with the largest weight of the set, or larger. It may be convenient to use a reference mass equal to the sum of all the weights, or if suitable intervening weights are available, it may be even larger.

By way of illustration, we assume a 100-lb, standard weight is to be used. Here we must have an auxiliary whose weight is not less than 100 minus 64 lbs. Thus the next weight of the series, $64P$, would suffice. To make full use of the example, we shall assume a 50-lb. auxiliary, which we designate $50A$. We now treat the auxiliary, $50A$, and the standard, $100S$, just like any weight of the set, and seek their relative values by suitable comparison with the lesser weights. In the calculations, Table IV, we have taken the relative value of $50A$ to be 49990 units, that of $100S$ to be 99778 units, and the certified value of $100S$ to be 99932 millipounds.

TABLE IV—CALIBRATION BASED ON A CERTIFIED 100-lb. WEIGHT

Denomination	Aliquot fraction	Old-unit (relative) values	Old-unit (relative) aliquot	Old diff.	New diff.	New-unit (absolute) aliquot	New-unit (absolute) value	Final corr.
$100S$	1	99778	99778	...	...	99932		
$50A$	2	49990	49889	101	101	49966	50067	67
$32P$	100/32	31939	31929	10	10	31978	31988	−12
$16P$	100/16	15971	15964	7	7	15989	15996	− 4
$8P$	12.5	7982	7982	0	0	7995	7995	− 5
$4P$	25	3990	3991	− 1	− 1	3997	3996	− 4
$2P$	50	1985	1996	−11	−11	1999	1988	−12
$1P$	100	990	998	− 8	− 8	1000	992	− 8
$\frac{1}{2}A$	200	496	499	− 3	− 3	500	497	− 3
$\frac{1}{2}P$	200	500	499	+ 1	+ 1	500	501	+ 1

TABLE V—CORRECTIONS BASED ON DIFFERENT METHODS OF ADJUSTMENT

	1	2	3
$32P$	13	0	−12
$16P$	8	1	− 4
$8P$	0	− 3	− 5
$4P$	− 1	− 2	− 4
$2P$	−10	−11	−12
$1P$	− 8	− 8	− 8
$\frac{1}{2}A$	− 3	− 3	− 3
$\frac{1}{2}P$	+ 1	+ 1	+ 1

Column 1: The sum of corrections equal to zero.
Column 2: The correction of $32P$ equal to zero.
Column 3: Absolute values, by comparison with a certified weight.

TABLE VI—CALIBRATION COMPUTATION FOR A "CHAINOMATIC" BALANCE

Denomination	Aliquot fraction	Relative value	Relative aliquot	Rel. diff.	Abs. diff.	Absolute aliquot	Absolute value	Final corr.*
$100S$	1	9957	9957	..	..	10002		
$100C$	1	10025	9957	68	68	10002	10070	70
$90C$	10/9	9015	8961	54	54	9002	9056	56
$80C$	10/8	8030	7966	64	64	8002	8066	66
$70C$	10/7	7027	6970	57	57	7001	7058	58
$60C$	10/6	6025	5974	51	51	6001	6052	52
$50C$	2	5021	4979	42	42	5001	5043	43
$40C$	10/4	4019	3983	36	36	4001	4037	37
$30C$	10/3	3027	2987	40	40	3001	3041	41
$20C$	5	2017	1991	26	26	2000	2026	26
$10C$	10	1010	996	14	14	1000	1014	14
$10A$	10	1000	996	4	4	1000	1004	4

*(In 0.1 mg.)

The results of the various systems of adjustments are shown in Table V, in which it may be noted that only the algebraic order of magnitude is preserved. It is to be emphasized that all these systems are interconvertible, and merely represent the same calibration based on different-sized units.

CONTINUOUS SCALES

Continuous scales, as distinguished from discrete sets, may be exemplified by the etched linear scale on a glass burette, which is taken as a measure of the related volume inside. Errors arise from inaccurate positioning of the scale markings, and from variations of the inner cross-section of the burette. Because of the latter, the problem is at once removed from the class of linear measurement, and calibration requires direct comparison of the scale markings with the contents. For this purpose we employ a small auxiliary standard of measure, which we shall term a "transfer standard." This transfer standard, which must be an aliquot of the full-scale reading, is applied successively to each scale interval, just as in the weight calibration. In the case of the burette, the transfer standard might well be a 5-, 10-, or 25-cc. pipette.

In the case of the "Chainomatic" balance, now to be described, the situation is similar. The errors arise from incorrect positioning of the scale marks on the column, incorrect chain length, and variation of the chain weight from point to point. The latter may arise, for example, by slight stretching of a link, by wear, or by settling of some foreign substance upon the chain. For calibration, the transfer standard takes the form of a small weight, of say 5, 10, 20, or 25 mg., assuming the balance has a 50-, 100-, or 200-mg. chain.

Let the chain be 100 mg., and let a 10-point calibration be required. We require a 10-mg. weight, to which we assign the value 1000 units, each unit being close to 10 micrograms. Comparing this weight, $10A$, with the 0 to 10 mg. interval of the chain, using Borda's method,[3] we find, let us say, the latter weighs 1010 units. Now comparing the 0 to 10 interval plus $10A$, total 2010 units, with the 0 to 20 interval, we find the latter is, say, 2017 units. Continuing in this way, and tabulating our results in descending order, we obtain a set of relative values such as appears in Table VI. The calibration is based on a 100-mg. standard weight set, of 9957 units. Computations are similar to those already described.

MATHEMATICAL BASIS

Let r and s represent the relative unit value and the final standard value, respectively, for any chosen interval. Let R and S be the corresponding values for the reference standard. Then for each interval:

$$s/r = S/R$$

Introducing the divisor a, and rearranging, this may be written

$$s = [S/R]\,[r - (R/a)] + [S/a]$$

The first column in the tabulations gives the nominal value and the designation of each interval. The next column gives the aliquot fraction, or submultiple, a. The relative values, r, and the relative aliquots, R/a, follow in the next two columns, respectively. The first and second difference columns will be recognized as containing the quantities $r - R/a$ and $(S/R)(r - R/a)$, respectively, in which S/R is the aforementioned conversion ratio. Because of the manner of choosing the quantities a, the differences will in general be small, and the two difference columns will contain nearly, if not entirely, identical figures.

The usefulness of the method consists first of all in a viewpoint, and second in a simplified, tabular procedure. The power of the arithmetic method lies in the replacement of multiplications by additions. The formal arrangement of the work is conducive to directness and accuracy.

REFERENCES

[1]T. W. Richards. Note on a Method of Standardizing Weights. *Journal American Chemical Society*, Vol. 22, 1900, pages 144-149.
[2]Ellis Blade. Calibration of Weights. *Industrial & Engineering Chemistry*, (Anal. Ed.), Vol. 11, 1939, pages 499-501.
[3]H. A. Fales & F. Kenny. Inorganic Quantitative Analysis. (2nd Ed.) D. Appleton-Century Co., New York, 1939.
[4]C. A. Briggs & E. D. Gordon. Weighing by Substitution. *National Bureau of Standards Technical Paper No. 208* (1922).
[5]F. H. Hurley, Jr. Calibration of Weights. *Industrial & Engineering Chemistry*, (Anal Ed.), Vol. 9, 1937, pages 239-243.

EDUCATIONAL and TRAINING COURSES

Preliminary Report on Survey of Curricula

By RICHARD RIMBACH
President, The Instruments Publishing Co.

A form letter of inquiry, which asked if the curriculum included courses devoted to measurement, inspection, testing and control, was addressed to 283 engineering schools, colleges and universities. Answers were received from so few that a letter was then sent out requesting catalogues giving descriptions of their courses. With the aid of a second letter 190 catalogues were received. The work then started.

All course descriptions were read, even though the title of the course did not indicate that the course was devoted to instrumentation. The tabulation herewith is only preliminary and is published at this time to arouse further interest in the subject of education in measurement, inspection, testing and control, on the part of readers. It is hoped that readers will check over the table carefully and write in, advising which corrections and additions are necessary.

Due to the fact that some of the college catalogues do not give complete course descriptions and others only list titles, the tabulation cannot be complete but it is expected that this will be remedied by correspondence.

Courses in surveying were not included in the tabulation because *all* civil engineering departments have surveying courses. Most physics departments have physics laboratory courses but the extent to which they cover measurement or instrumentation is not clear from the course descriptions.

It is also obvious that all metallurgical departments include metallography but here again this was not clear from the catalogues.

Practically all engineering schools have courses in testing materials but again this is not clear from the descriptions. Therefore not many courses in testing materials appear in the tabulation. The same holds for hydraulics or the flow of liquids. Courses in testing materials and flow measurement are given by different departments in different schools, indicating that knowledge of these subjects is not limited to certain departments of instruction.

In this tabulation, the courses of instruction are listed across the top and the schools down the side at the left. The letters appearing in the various columns are abbreviations and represent the departments of instruction; for example A.E. represents the department of Aeronautical Engineering.

Adm.	Administrative Engineering
A.E.	Aeronautical Engineering
A.M.	Applied Mechanics
A.M.2	Applied Mathematics
C.	Chemistry
C.E.	Chemical Engineering
Cer.	Ceramic Engineering
Civ.	Civil Engineering
E.E.	Electrical Engineering
E.E.2	Experimental Engineering
E.M.	Engineering Mechanics
Eng.	Engineering
E.P.	Engineering Physics
G.	Geology
G.E.	Gas Engineering
Gen. E	General Engineering
I.E.	Industrial Engineering
M.E.	Mechanical Engineering
M.	Meteorology
M.E.B.	Mechanical Equipment of Buildings
Mech.	Mechanics
Met.	Metallurgical Engineering
M.M.	Manufacturing & Management
M.S.P.	Machine Shop Practice
O.G.P.	Oil & Gas Production
P.	Physics
P.E.	Petroleum Engineering
Phys.	Physiology
P.P.M.	Pulp & Paper Manufacture
P.S.	Photographic Subjects
P.W.E.	Public Works Engineering
R.E.	Radio Engineering
S.S.	Social Science
T.E.	Textile Engineering
T.T.	Technical Training

Below are instrument courses which are not given by enough schools to want their being included in the above table. The course is listed and below each course is listed a letter corresponding to the department and following the letter, the school.

X-Rays
P. Colorado School of Mines
P. Kansas State College
P. Ohio State University
P. Purdue University

Meteorology
Civ. Colorado State College
P. Iowa University
M. New York University
A.E. Notre Dame University
A.E. Massachusetts Institute of Technology

Textile Testing
T.E. Georgia Institute of Technology
T.E. Lowell Textile Institute
M.E. Massachusetts Institute of Technology

Glass Blowing
P. Iowa State College
P. Kansas State College
E.P. Oklahoma University
C.E. Rensselaer Polytechnic Institute

Physico-chemical Measurements
C. Lafayette College
C. Michigan University
C. Oregon State College

Internal Combustion Engine Testing
M.E. Louisville University
M.E. Minnesota University

Metrology (Gages & Gaging)
M.E. New Hampshire University
M.E. Stanford University
M.E. George Washington University
M.E. Massachusetts Institute of Technology

Paper Testing & Analysis
C.E. Maine University
P.P.M. New York State College of Forestry

Hydrogen Ion Concentration
C. Notre Dame University

Physical Measurements
P. Notre Dame University
P. Oklahoma University
P. Oregon State College
P. Pennsylvania State College

Gas Measurements
M.E. & P.E. Oklahoma University
O.G.P. Pittsburgh University

Optical Instruments
P. Rensselaer Polytechnic Institute

Instrument Making
M.S.P. Rochester Anthenaeum & Mechanics Institute

Photomicrography
P.S. Rochester Anthenaeum & Mechanics Institute
M.E. Southern California University

Instrumental Analysis
C. Rutgers University
C. Utah University

Oil Field Testing Methods
P.E. Southern California University

Magnetic Measurements
P. Tennessee Polytechnic Institute

Vibration
A.E. Massachusetts Institute of Technology

Color Measurements
P. Massachusetts Institute of Technology

Servo Mechanisms
E.E. Massachusetts Institute of Technology

Instrument Course at Illinois Tech

Illinois Institute of Technology has inaugurated an evening graduate course by Professor Harry McCormack and visiting lecturers, entitled Process Control Through Instrumentation. A study is made of the instruments which are or may be used to indicate, record and control temperature, pressure, rate of flow, ratio of materials, hydrogen ion concentration or such other variables as may exist in an industrial process. Credit allowed in any field of engineering or science.

[Called to our attention by the Chicago Society for Measurement and Control.]

Two Testing Courses at Pitt

[Received Feb. 6]

U. S. Office of Education
Engineering Defense Training
University of Pittsburgh
Courses in Spectroscopic Testing of Materials and X-ray Testing of Materials

The purpose of all courses is to prepare men along definite lines to fill technical positions in government service and in industry as and when they may occur in the development of our national defense program. All courses will be of college grade *although no college credit will be given.*

Tuition and laboratory supplies will be free. Students must purchase their own textbooks.

Registration January 27-February 1, 6:30-10:00 P. M., Room 104 Thaw Hall. Classes will start the week of February 3 in accordance with day and hour schedule indicated for each course and continue through June 28.

Additional information may be obtained by phone (MA. 3500) or application to Department of Physics, University of Pittsburgh, or to J. S. Lambie, Director, Engineering Defense Training Program, 107 State Hall, University of Pittsburgh.

Case School Instrumentation Course Becomes Part of Defense Program

The intensive evening course in Instrumentation given at Case School of Applied Science has been modified and is included as part of Case's contribution to the National Defense Training Program. A laboratory has been organized with the help of W. E. Sachse of the Standard Oil Co. of Ohio. Directed by Professor C. O. Miller (Dep't of Chem. Eng.) the course began February 4 with more than ninety students selected from about 150 applicants. It is scheduled to end on April 29. The schedule of lectures was published in the Dec. 1940 *Instruments*, page 396, but it is to be noted that practical laboratory work with industrial instruments now constitutes an added feature of the course.

Schools which replied. (Those which did not reply to THREE successive requests not listed.)	Electrical Measurements	Mechanical Laboratory	Aircraft Instruments	Motion & Time Study	Temperature & Pyrometry	Hydraulics (Flow of Liquids)	Microscopy	Optics & Light	Industrial Instrumentation	Gas, Oil & Fuel Analysis	High Frequency Measurements	Navigation	Electronics	Spectroscopy	Testing Materials & Physical Testing
Akron University	E.E.														
Alabama Polytechnic Institute	E.E.	M.E.	A.E.												
Alabama University	E.E.	M.E.		M.E.	Met.										
Antioch College	P.					Eng.	P.								
Arizona University	P.					Civ.									
Arkansas University	E.E.														
Armour Inst. of Technology	E.E.	M.E.			P.& C.E.			P.							
" " Evening School				S.S.		Mech.			P.						
Bradley Polytechnic Institute	P.		A.E.												
Brooklyn Polytechnic Inst. E. S.	P.& E.E.					M.E.	P.			M.E.	E.E.			P.	
Brown University						Eng.						Eng.	E.E.		
Bucknell University	P.				P.								E.E.		
Catholic University	P.														
Chicago University														C.	
Cincinnati University	E.E.	M.E.			C.E.									E.E.	
Clarkson College of Technology		M.E.				M.E.			E.E.						M.E.
Clemson Agricultural	E.E.	M.E.				Civ.& M.E.				M.E.					
Colorado College	P.									C.					
Colorado School of Mines	P.														
Colorado State College						Civ.									
Colorado University	P.	M.E.				Civ.									
Columbia University		M.E.							M.E.						
Cooper Union Institute of Tech	E.E.	M.E.													
Dayton University	P.														
Delaware University		M.E.													
Detroit Institute of Technology	E.E.														
Detroit University	P.				P.										
Drexel Inst. of Technology	P.& E.E.	M.E.													
" " Evening School						P.W.E.									
Duke University	P.										E.E.				
Florida University	E.E.												E.E.		
Georgia Institute of Technology		M.E.	A.E.	M.E.		M.E.	Cer.		P.						
Grove City College						Eng.									
Harvard University													E.E.		
Hawaii University						Civ.									
Hopkins University, John	E.E.					C.E.				G.E.					
Illinois Inst. Tech. Even. School									C.E.						
Illinois University	P.& E.E.	M.E.			Cer.		Cer.								
Indiana Technical College	E.E.		A.E.			Civ.					R.E.				
Iowa State College		M.E.		M.E.	Cer.			P.							
Iowa University	P.				P.					C.				P.	
Kansas State College	E.E.					A.M.	C.& G.								
Kansas University	P.	M.E.		M.E.	P.			P.	C.E.	M.E.					Civ.
Kentucky University	P.	M.E.			P.										
Lafayette College	P.& E.E.					Civ.							P.	P.	
Lehigh University		M.E.			P.									P.	
Louisiana State U. & A. & M. Col	P.& E.E.														
Louisville University	P.					M.E.									
Lowell Textile Institute							T.E.								
Maine University	E.E.	M.E.									E.E.				
Manhattan College	E.E.														
Maryland University		M.E.					C.						E.E.		
Massachusetts Institute Tech	E.E.	M.E.	A.E.		M.E.	Civ.	P.& M.E.	P.	A.E.				P.	P.	M.E.
Massachusetts State College						Eng.									
Michigan Coll. Mining & Tech	P.	M.E.			Met.								P.& E.E.		
Michigan State College	E.E.				C.E.								E.E.		
Michigan University	P.& E.E.				Met.						P.		P.& E.E.		E.M.
Minnesota University	E.E.	M.E.	A.E.								E.E.				
Mississippi State College				M.E.	P.										
Missouri University									C.E.						
Nebraska University	E.E.														
Newark School of Engineering	E.E.														
New Hampshire University	P.					Civ.							E.E.		
New York City College	E.E.														
New York State College Cer					Cer.										
New York State College Forest															
New York University	P.& E.E.		A.E.	Adm.		E.M.			C.E.				E.E.		
North Dakota Agri. College		M.E.													M.E.
North Dakota State College	P.					Civ.									
North Dakota University					C.E.										
Northeastern University	E.E.					C.E.					E.E.				
Northwestern University						Eng.									
Notre Dame University		M.E.	A.E.							C.E.					Met.
Ohio State University	P.	M.E.		I.E.	P.& Met.	M.E.		P.					P.& E.E.	P.	
Ohio University	E.E.												E.E.		
Oklahoma University	E.P.					E.M.& M.E.									E.M.
Oregon State College									M.E.	C.					
Pennsylvania State College	P.& E.E.	M.E.			P.								P.		E.M.
Pennsylvania University		M.E.							C.E.						
Pittsburgh University	P.			I.E.											
Princeton University	E.E.														
Puerto Rico University											P.				
Purdue University	E.E.	M.E.			Met.	Civ.	C.								
Rensselaer Polytech. Institute		M.E.				M.E.								P.	
Rochester Anthenaeum								M.E.B.							
Rutgers University	E.E.										E.E.		E.E.		
Santa Clara University	P.												E.E.		
South Dakota School of Mines	E.E.														
Southern California University	E.E.	M.E.				Gen.E.				C.E.					
Southwestern Louisiana Inst		M.E.													
Stanford University	E.E.				Met.	E.M.									
Stevens Inst. of Tech	E.E.												E.E.		
Syracuse University	E.E.	M.E.													M.M.
Tennessee Polytechnic Institute	P.					Civ.									
Tennessee University	P.	M.E.													
Texas A. & M. College	E.E.	M.E.				Civ.									
Toledo University	E.P.														
Tufts College											E.E.				
Tulsa University										P.E.					
Utah University		M.E.				Civ.									
Vanderbilt University						Mech.									
Vassar College														Phys.	
Villanova College						Civ.									
Virginia Polytechnic Institute				I.E.	P.		Cer.	P.			P.			P.	
Virginia University	E.E.	E.E.2				A.M.2 & E.E.2				E.E.2	E.E.				E.E.2
Washington State College	E.E.					Civ.									
Washington University		M.E.													
Washington University, George	E.E.	M.E.													
Wayne University	P.	M.E.			C.E.	Civ.		P.							
Western Reserve University							C								
Wisconsin University									C.E.						
Worcester Polytechnic Institute		M.E.				M.E.	C								
Wyoming University	E.E.					Civ.									

INSTRUMENTS' BOOK SHELF

Temperature — Its Measurement and Control in Science and Industry. Papers presented at 1939 Temperature Symposium of American Institute of Physics. Edited by C. O. FAIRCHILD, J. D. HARDY, R. B. SOSMAN and H. T. WENSEL. Reinhold Publishing Corp., New York, 1941. Cloth, 6 × 9¼ inches, xiii + 1362 pages. Price $11.00.

At last here is the successor to the classic Pyrometry Symposium of 1920—a longer book, covering a much wider range of topics. As every reader knows, the American Institute of Physics held a Temperature Symposium in November 1939, which occupied three full days, with sessions simultaneously going on in a number of meeting-rooms. As every reader knows, likewise, the Institute had the coöperation of the National Bureau of Standards, the National Research Council, and officers and committees of twelve societies and associations—not to mention hundreds of individuals.

As few readers know, however, the editors invited additional contributions in an attempt to round out the book—in an attempt to make it true to its title. It is to be regretted that an insufficient number of authors responded, so that the words "and Control" as well as the words "and Industry" in the title are barely justified. This is a scientific reference work. As such, it is a masterpiece, a monument, a classic. It is an absolute MUST for scientific research laboratories, teachers of various sciences, etc.

Naturally, it is not a book for beginners. For example, if a typical reader of *Instruments*, employed in an industrial plant, were to consult this book in order to learn about radiation pyrometers, he would find nothing of a general nature except a few formulas; and if he wanted to learn about the various classes and types of radiation pyrometers, he would only find a few words in the paper on classification of instruments. But he would find a nineteen-page description of one new model of one commercial make! Now it may be perfectly true that this nineteen-page description is the best description of a particular model of radiation pyrometer ever written: it is not an advertisement but a factual description with three tables (which are nearly three pages long) and thirteen illustrations including diagrams of calculated and obtained characteristics. But that's not what engineers, foremen, production executives and other industrial instrument users *want*. That certainly is not what these practical users *need*.

The same remark applies to almost every division of industrial temperature instrumentation. Admirable papers and famous specialists on highly-specialized subjects, and almost nothing of a general nature. Nothing at all, for example, designed for the practical man who wants to know the elementary principles of automatic temperature control: the only general treatment of automatic temperature control is the masterly—but entirely mathematical—paper by C. O. Fairchild.

Nevertheless, having leaned over backward and written this warning, the reviewer does not hesitate to declare that every industrial plant where there is an engineer or a research man who is no longer a beginner in temperature instrumentation will find this book well worth its price. The reason we make this positive statement is that among the 124 individual contributions, there are many which will undoubtedly be found to supply valuable information on special problems.

Just a few examples:

Pyrometry in Connection with Creep Tests by F. H. Norton;

Control and Measurement of Temperature under the Microscope by C. F. Saylor;

Thermal Prospecting for Oil by M. C. Terry and J. H. Burney;

Thermocouples for Testing Steam Turbines by B. O. Buckland and S. S. Stack;

Temperature Measurement in the Molding of Plastics by J. Delmonte;

Thermometers for Aircraft by W. G. Brombacher;

Temperature Radiation Emissivities and Emittances by A. G. Worthing.

Which is to say, of course, that this book fully deserves the oft-misapplied bouquet: "a Mine of Information."

—M. F. BEHAR

Geophysical Exploration. By C. A. HEILAND. Prentice-Hall Inc., New York, 1940. Cloth, 6 × 9 inches, xiii + 1013 pages. Price $10.00.

The past twenty years has witnessed the development of a vast commercial application of physics and physical instruments to prospecting for minerals—petroleum and ores—which lie buried in the earth. (The oil industry in the United States alone expended about twenty-five million dollars in 1940 on this work). This application of the methods of physics to economic geological problems is called *applied geophysics* or *geophysical exploration* and is only genetically related to the older academic *geophysics* which concerns itself with the nature of the earth as a whole. A book treating the modern developments in applied geophysics has been needed badly. The present volume fills this need.

Dr. Heiland (Professor of Geophysics, Colorado School of Mines) has taken an active part during the whole period of development of applied geophysics in the laboratory, in the field, and in the classroom, and is a recognized authority on the subject. His book covers the entire field of application—not only to exploration for minerals but also to civil, structural, mining and military engineering, engineering geology, etc.

An unusual feature in a treatise of this kind is its division into two dissimilar parts. Part I of 64 pages ". . . written in elementary language, addresses those desiring an insight into the working principles and geological applications of geophysical methods." Part II which covers the rest of the book is ". . . for the technical student of geophysics. It presents the subject from an engineering point of view, striving at a balanced discussion of theory, field technique, laboratory procedure, and geological interpretations." The geophysical methods considered are gravitational, magnetic, seismic, electrical (including radio), thermal, radioactive, acoustic and geochemical (soil and soil gas analysis).

An important part in the success of geophysical prospecting is due to the development of special instruments. These instruments must be of high precision, even according to laboratory standards, and yet be able to operate rapidly under sometimes almost unbelievably adverse field conditions. For example, gravimeters are available today which measure variations in gravity to one part in ten million or better and require less than five minutes per setup. The theory and technique of the various geophysical instruments are presented quite comprehensively in this book. Also included are excellent tables of the pertinent physical properties of rocks, such as density, magnetism, elasticity, resistivity, dielectric constant, radio-activity, etc.

In the reviewer's opinion the technical treatment may be rather difficult for the beginner. Some of the descriptive sections introducing the mathematical portions do not present the physical principles as clearly as could be desired. Also, many results are stated without derivation and there are a number of forward references. The apportionment of space to a geophysical method may be misleading to the novice as it appears to be regulated more by the material available in the literature than by the present practical importance of the method (e.g., one hundred pages are devoted to an extremely detailed exposition of all phases of the now practically obsolete Eotvös torsion balance method). Also, the book is inconveniently under-sectionized for rapid reference use.

The scope of the book is encyclopedic and it is indispensable to the professional geophysicist. Economic geologists will find it useful. Part I should also be of interest to physicists and engineers who wish to be informed of important recent technical applications of physics.

—SIGMUND HAMMER, *Gulf Research & Development Co., Pittsburgh, Pa.*

Cathode-Ray Oscillographs. By J. H. REYNER. Sir Isaac Pitman & Sons, Ltd. London, 1939; Pitman Publishing Corp., New York, 1939. Cloth, 5 × 7½ inches, viii + 175 pages. Price $3.40.

A pocket-sized manual, containing the basic information on the Cathode-ray Oscillograph as a measuring instrument for the laboratory and the various fields of industry. It is a practical treatise, written for the individual who regards an oscillograph as a means to an end, and who is interested in utilizing the instrument to greatest advantage, serving as a useful supplementary instruction manual. Little material has been included on such matters as tube design or a theoretical consideration of the circuits shown. The book does include, however, the basic principles of the oscillograph and the commoner types of associated circuits and equipment.

There are nine chapters in all: taking up the tube, its use in an oscillograph, time base oscillators of various types, and deflection amplifiers. Then particular applications are taken up, considering the general subjects of waveform analysis, frequency-response curves, vacuum-tube characteristic curves, frequency comparisons, radio frequency studies (modulation tests, etc.) and one chapter is devoted to miscellaneous special applications.

The methods and circuits described are, for the most part, classical and nothing has been noted therein, by this reviewer, with which anyone might disagree. In regard to some of the equipment setups mentioned, however, it seems that greater value would be provided by the inclusion of more information as to useful circuit values or else the rules whereby those values could be readily ascertained for use in duplicating any of the apparatus.

—RALPH R. BATCHER, *Electronics and Cathode-ray Technician, Hollis, New York.*

Reports on Progress in Physics. Vol. V. ALLAN FERGUSON, General Editor for THE PHYSICAL SOCIETY. The University Press, Cambridge, England, 1939. Cloth, 7 × 10 inches, vi + 445 pages. Price 20s. (or $5 according to order blank for U. S.).

Again it is our pleasure to be able to repeat the statement in our review of Volume III, two years ago, and of Vol. IV, a year ago:

"This periodical gets better every year . . . is rather spotty . . . as a whole a meaty permanent reference . . . about 160,000 words . . . most authors have striven to prepare terse corelated abstracts rather than verbose essays . . ."

This volume, though, has about 200,000 words.

In the brief Preface, Dr. Ferguson makes his farewell bow as editor and introduces his successor (Dr. Awbery) as Papers Secretary to The Physical Society. He has set a high standard for his successor to follow. This reviewer is inclined to agree with

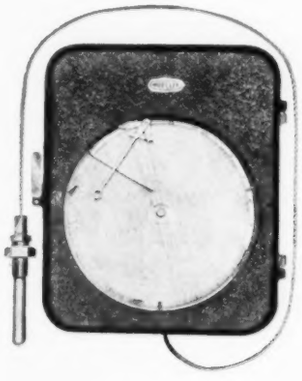
MOELLER

PRECISION GRADE INSTRUMENTS

☆

MOELLER MERCURY THERMOMETERS are made with the Moeller Glass Red Reading Column making them easy to ready under varying light conditions, at a considerable distance and over a wide range.

MOELLER DIAL THERMOMETERS are made in various scale ranges up to 1000°F. or equivalent. Metal and Phenolite cases.



MOELLER RECORDING THERMOMETERS are likewise furnished in various ranges up to 1000°F. or equivalent. Round and square cases as preferred.

Also HYGROMETERS
RECORDING PSYCHROMETERS
BAROMETERS HYDROMETERS
MARINE INSTRUMENTS, ETC.

Write for catalog.

MOELLER INSTRUMENT COMPANY
132nd STREET and 89th AVENUE
RICHMOND HILL NEW YORK

Sales Representatives in Principal Cities

For ACCURATE OSCILLOGRAPHIC MEASUREMENT of *PRESSURE VARIATIONS...*

RCA Type 319-A Pre-Amplifier

★ *Linear within 6% . . . 2 to 17,000 Cycles*
★ *Voltage Gain to 45,000 x*
★ *Measures Conversion-Unit Input Voltage*
★ *Distortion: Less than 3% Total Harmonics*
★ *Output to 60 volts, R.M.S.*
★ *Input Impedance: 90 Megohms*

For engine-pressure studies and similar industrial measurements, this RCA Type 319-A Pre-Amplifier is the ideal bridge between your pressure-conversion unit and your oscillograph.

Designed to amplify with negligible distortion the highly irregular wave-forms from a pressure-conversion unit such as the RCA Type 307-A before passing them to the oscillograph vertical-deflection circuits, the 319-A also permits precise *measurement* of the input voltages . . . by comparison with a calibrating voltage drawn from the power-source (usually a 60-cycle, 110-volt line). An additional control provides for superimposing on the pressure trace a marker-voltage generated by the Synchronizer unit, where desired.

Affording overall voltage gain as high as 45,000 . . . frequency-response flat within ±6% from 2 to 17,000 cycles . . . and output voltage up to 60 volts R.M.S. . . . the RCA 319-A Pre-Amplifier is suitable for many other types of oscillographic measurement—wherever highly irregular wave-forms must be amplified with virtually no discrimination or distortion. Write for complete data on the RCA Type 319-A Pre-Amplifier and other RCA Industrial Pressure-Study Equipment.

Use RCA Tubes in your measuring equipment for greater precision.

RCA *Measuring Equipment*

RCA Manufacturing Company, Inc., Camden, N. J.
A Service of the Radio Corporation of America
In Canada, RCA Victor Company, Ltd., Montreal

New York: 1270 Sixth Ave. • Chicago: 589 E. Illinois St. • Atlanta: 530 Citizens & Southern Bank Bldg. • Dallas: Santa Fe Bldg. • San Francisco: 170 Ninth St. Hollywood: 1016 N. Sycamore Avenue

the following remarks which Dr. Ferguson makes in the preface:

"I have preserved a certain elasticity of outlook and openness to argument, not attempting to fit the matter of the Reports into an over-rigid scheme. There have resulted, in consequence, slight variations from year to year in the content and outlook of the Reports which have not been altogether to their disadvantage. The web of the volumes is 'of a mingled yarn' but right through it has run one thread of policy—the endeavour to present articles which shall discuss the latest developments in physical science, and which shall at once make clear to the non-specialist the meaning and extent of these advances, and provide the researcher in the particular field under discussion with a technical résumé helpful to him in his own work."

As in our previous reviews of the earlier annual volumes, we believe that it will be most convenient for the readers of *Instruments* to have us give them the topics, the authors, the numbers of pages and the numbers of references. This analysis follows:

General physics—I. Surface tension. By R. C. Brown: 8 p., 33 refs.; II. Brownian motion. By R. C. Brown: 3 p., 24 refs.; III. Elasticity. By H. L. Cox: 7 p., 47 refs. (of which 3 are U. S.); IV. The viscosity of non-Newtonian fluids. By C. F. Goodeve: 9 p., 50 refs.

The absorption theorem of J. Willard Gibbs. Anomalies in applying it to surface tension curves that exhibit minima in dilute solution. By J. W. McBain and G. F. Mills: 14 p., 59 refs. in two parts.

Recent theories of the liquid state. By N. F. Mott and R. W. Gurney: 18 p., 25 refs.

Plastics in industrial physics. By H. W. Melville: 18 p., 39 refs. (some of them classified).

Recent progress in astronomy. By A. C. D. Crommelin: 18 p., 5 refs.

Meteorology. By D. Brunt: 18 p., 127 refs.

Sound. By E. G. Richardson: 27 p., 94 refs.

Instrumental aids for defective hearing. By Phyllis M. Tookey Kerridge: 13 p., 27 refs. classified in three parts.

Heat. By R. W. Powell: I. The Equation of State. 3 p., 26 refs.; II. Thermal Diffusion. 1 p., 14 refs.; III. The Measurement of Temperature. 2 p., 18 refs.; IV. Calorimetry and Specific Heat. 3 p., 23 refs.; V. The Conduction of Heat. 7 p., 38 refs.

Optics. Editor, L. C. Martin: I. General introduction. By the Editor. II. Optical instruments and the theory of optics. By L. C. Martin: 3 p., 18 refs.; III. Recent developments in optical glass manufacture. By W. M. Hampton and W. N. Wheat: 5 p., 44 refs.; IV. Advances in the theory of photography. By E. W. H. Selwyn: 9 p., 52 refs.; V. Television optics. By W. D. Wright: 9 p., 3 refs.

Spectroscopy. Editor, W. Jevons: I. Atomic spectra. By Professor A. G. Shenstone: 16 p., 117 refs.; II. Hyperfine structure. By M. F. Crawford: 6 p., 23 refs.; III. The Stark effect and some related phenomena. By J. Stuart Foster: 8 p., 25 refs.; IV. Astronomical spectroscopy. By A. Hunter: 8 p., 17 refs.; V. The spectra of the alkali-metal hydrides. By R. W. B. Pearse; 8 p., 8 refs.

The soft x-ray spectroscopy of the solid state. By H. W. B. Skinner: 26 p., 44 refs.

The use of x-rays and γ-rays in medicine. By W. V. Mayneord: 17 p., 66 refs.

Absolute electrical measurements. By L. Hartshorn: 31 p., 47 refs.

Electric wave filters. By N. F. Astbury: 14 p., 34 refs.

Atomic physics—I. The single scattering of elementary particles by matter. By F. C. Champion: 13 p., 49 refs.; II. Cosmic rays. By W. Heitler: 28 p., 67 refs.

The mechanism of the Geiger counter. By A. Nunn May: 11 p., 48 refs. in six parts.

Some difficulties and developments in quantum mechanics. By H. T. Flint: 20 p., 22 refs.

The teaching of physics in schools. By A. W. Barton: 24 p., 5 refs.

As in the preceding volumes, the range of subjects is wide—but of course not complete. Again, the reason for the omission of certain topics is that they were admirably covered in one or more of the preceding volumes and that one year's wait is not seriously detrimental.

Comments upon even a few of the reports in this volume would make this review over-long. Although the reviewer has skimmed through every page of this volume, he has not undertaken to read closely more than one-third of the reports. These he found attractively written and, in some cases, excellently illustrated. Dr. Kerridge seems to deserve a five-star mention for her full-page "engineering" drawing of the construction of the human ear. She has unrolled the rolled-up parts, and otherwise shown the ear as a physical instrument.

Dr. Hartshorn's report on absolute electrical measurement (31 p.) is almost a book in itself, excellently divided into ten chapters.

As we wrote of previous volumes: "No physical research laboratory is completely equipped if it lacks this volume and its precursors."

—M. F. Behar

Cumulative Index, *Journal of the Acoustical Society of America,* **Vols. 1-10 (1929-1939).** Edited by F. A. Firestone. American Institute of Physics, New York, 1940. Paper, 8 x 10½ inches, viii + 132 pages. Price $3.

Covering as it does the decade that witnessed greater advances in sound technology than did the century 1829-1928, this compilation will be used so frequently by interested workers that we wonder why the A.I.P. did not issue it in a durable binding.

It may be said to comprise two separate indexes: one to the *Journal* (Oct. 1929-Apr. 1939) and one to the 3500-odd papers published elsewhere and reported in the *Journal* (Apr. 1937-Apr. 1939). Each of these, in turn, is divided into an Author Index and a Subject Index.

Greatest aid to the busy reference-hunter is the systematic classification of subjects: twelve main headings and ninety-six numbered sub-heads, some of which comprise a plurality of related topics so that nearly two hundred individual topics are covered. The main heading "5. Applied Acoustics, Instruments and Apparatus" has nineteen sub-heads, among them these typical examples: "5.5 Audiometers (see also 4.4 and 4.5)" "5.11 Oscillators" and "5.15 Sound Level Meters, Level Recorders, Sound Pressure Measurement (see also 5.4)."

This classification appears on two pages, and each sub-head is followed by two page numbers, one for the subject index of *Journal* articles and abstracts, the other for the Contemporary Literature subject index.

Evidence of the loving care with which the whole book was prepared is seen under each sub-head in the *Journal's* classified index: the individual items under each of these sub-heads are divided into Papers, Sub-titles and Abstracts. Thus, a lengthy article dealing with several distinct topics will be found cited under all of the sub-heads designating these various topics.

Three additional sources are a list of book reviews published by the *Journal* and the two lists of bibliographies (*Journal's* and contemp. lit.). These give a total of fifty-nine citations.

For scientific purposes, this book may be said to be comprehensive—almost exhaustive. But it does not pretend to include references to articles, bibliographies, etc., which appeared in industrial magazines, engineering journals and other periodicals not recognized by the A.S.A. librarian "as pertaining to the field of acoustics" (private communication from Dr. Firestone to the reviewer). This is not a shortcoming. Perhaps it makes the book more valuable, even to practical workers in development departments, inspection and testing departments, etc. Certainly it makes the book more *usable.* For if no sharp line had been drawn, the Contemporary Literature indexes would have filled hundreds of pages. As it is, all of us should be thankful that a scientific organization has for years been selecting the literature which it "recognizes as pertaining to the field" in which it is the world's most authoritative society.

—M. F. Behar.

TEST MAGNETIC PROPERTIES OF YOUR STEELS

THE ONLY SINGLE BUTTON ELECTRICAL RETURN FLUXMETER

SIMPLEST AND MOST EFFICIENT

Bulletin 504

THREE DIFFERENT STYLES

Portable Standard with single electrical zero return.

Switchboard Type with above zero feature located on flexible lead for bench operation.

Two Button Pointer Shift in place of our patented standard zero return at a lesser cost.

Acknouledged leaders in development of high sensitivity meters

RAWSON ELECTRICAL INSTRUMENT COMPANY

110 POTTER ST. CAMBRIDGE, MASS.

Branch: 15 East 26th St., New York City

Representative: E. N. Webber

4358 W. Roosevelt Rd., Chicago, Ill.

★ *NATIONAL* ★

RHEOSTATS

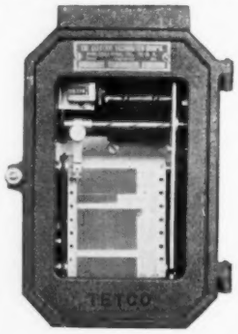
Ask for Catalog No. 5

National Electric Controller Co.

5317 Ravenswood Ave., Chicago, Ill.

TETCO

Speed Recorder



Creates a permanent time record on a waxed chart. Accurately records rate of production, time and duration of stops, total quantity produced.

The Electric Tachometer Corp.

1358 Spring Garden St., Philadelphia, Pa.

WHEN A RESISTOR SWEATS!

Moisture, visible or invisible, will cause trouble if it can penetrate the protective surface of a resistor. A microscopic examination of the surface of a Ward Leonard Vitreous Enamel Resistor will show why this Resistor is able to give satisfactory service under all climatic conditions. Its freedom from even minute enamel crazes or cracks is unique. With such complete protection of the wire, moisture is effectively excluded. The Vitreous Enamel of Ward Leonard Resistors is processed at a temperature above 1400°F. Thus all elements of the enamel are perfectly fused and envelop the wire in a sealed, protective, glass-like enclosure. Send for bulletins.

WARD LEONARD

38 SOUTH STREET — MOUNT VERNON, N. Y.

ELECTRIC CONTROL DEVICES SINCE 1892

New PRECISION PORTABLES

TRIPLETT

MODEL 625

Attractive Black Molded Case — Clear Readability — Long 4.58" Scale

Models 625 (DC—Moving Coil Type)—635 (AC—Movable Iron Vane Type) and 665 (Electrodynamometer Type) . . . new molded case portables, may be obtained with extreme sensitivity for laboratory use—as well as those for general commercial and industrial testing purposes. Have mirror scale and knife-edge pointer to assure quick, accurate readings. Scale length is 4.58"—Accuracy within 1%. Attractive black molded case, 6" x 5½" x 2½". Attached leather strap handle.

Another popular line of portables includes Models 725 (DC)—735 (AC). This popular style has a precision instrument with long 6" mirror scale. Oak case is 11" x 9" x 4".

Model 325 . 2.37" Scales—Models 325 (DC)—335 (AC) for laboratory, shop bench and special purposes. Tilting feature permits adjustment to any angle for accurate reading.

Model 525 . 3.50" Scale—Has mirror scale and knife edge pointer for extreme accuracy in reading.

To further meet the demand for portable instruments, Triplett has available handy instrument stands for 3" and 4" panel instruments; available with 2, 3, or 4 binding posts. Black wrinkle finish all metal case—sloping panel—4" x 4" x 3½".

Write for Catalog—Section 322 Harmon Avenue

THE TRIPLETT ELECTRICAL INSTRUMENT CO.
Bluffton, Ohio

HERE'S *"every-day"* DEPENDABILITY for service in plant or field!

M·S·A EXPLOSIMETER

Model 2

A COMPACT, SIMPLIFIED COMBUSTIBLE GAS INDICATOR

WITH THESE OUTSTANDING ADVANTAGES

DEPENDABILITY! Employs the same proved operating principle as Model 1—of which thousands are in service—the only available instruments of this type with a single control.

TRUE ONE-HAND OPERATION! Explosimeter *Model 2* requires the use of but one hand—leaving other entirely free to handle sampling line or probe.

ONE-PIECE FLOW SYSTEM! Cast integral with case—no tubing or connections to leak.

IMMEDIATE RESPONSE! Positive reading on second squeeze of bulb (with 5 ft. sampling line).

EASY-READING METER! Needle is always in view at any position on dial. Meter is a rugged airplane-type jeweled instrument—sturdy and well guarded.

LONG BATTERY LIFE! The standard flashlight batteries employed provide more than 10 hours of *continuous* operation—from 2 to 3 times the capacity of other combustible gas indicators.

BUILT-IN FILTER CHAMBER! With cotton insert, traps dust and moisture—or with charcoal cartridge, differentiates between illuminating gas and condensable, combustible vapors such as gasoline.

ON-OFF SIGNAL BAR! This device on control knob is raised when current is turned on, drops flush with knob when current is turned off—prevents instrument from being left with current on.

ON — OFF

SPARE FILAMENT IN CASE! While the low-cost, replaceable single filament used in Model 2 has a normal useful life of several thousand tests, a spare is contained in the case ready for instant use. Changed as easily as a light bulb!

SIMPLE CIRCUIT! With but a single filament—tried and proved in exhaustive field use—foolproof in hands of any workman.

SEPARATE BATTERY COMPARTMENT! Batteries entirely isolated from working parts of Explosimeter—no exposure of working parts when batteries are changed; no possibility of electrolyte from discharged cells affecting electrical controls.

LIGHTWEIGHT AND COMPACT! Skilled design has made the Model 2 Explosimeter remarkably rugged, compact and convenient to operate. It is as easy to use as it is comfortable to wear. Carrying straps are easily removed when desired.

Dimensions: 3⅜" x 5⅜" x 5½"
Weighs less than 4½ lbs. without carrying straps.

New Bulletin DN-4—and Demonstrations, Too!—Promptly Furnished on Request.

MINE SAFETY APPLIANCES CO.
Braddock, Thomas and Meade Sts. · Pittsburgh, Pa.
District Representatives in Principal Cities

A Greater Metallurgy Service

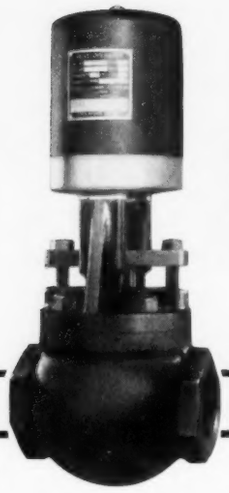
A greatly enlarged Metallurgy Division makes Permo Metal available to industry on an increased scale.

Permo Metal is a smooth, wear resisting, non-corrosive alloy with a low coefficient of friction, made of precious metals (Osmium, Ruthenium, etc.).

Instrument bearings, long life fountain pen tips, phonograph needles and contacts . . . are just a few of countless uses of these remarkable alloys.

An additional service of preliminary assembly of material to holder or shank is also available. Write for detailed data.

PERMO PRODUCTS CORP.
Manufacturing Metallurgists
6423 RAVENSWOOD AVENUE, CHICAGO, ILLINOIS



BARBER B-C COLMAN

Electric
MOTOR-OPERATED VALVES
FOR USE WITH
PYROMETERS
AND OTHER INSTRUMENTS

● Interrupted flow of gases or liquids can be accurately and automatically controlled by a suitable motor-operated valve or valves, governed by any standard make of pyrometer, or other controlling, recording, and indicating instrument. Barber-Colman ELECTRIC Motor-Operated Valves are designed for exceptionally long service life and minimum maintenance cost. They are available in a wide range of types and sizes for all kinds of heating and process applications.

Write for Descriptive Bulletins

BARBER-COLMAN COMPANY
1202 ROCK ST. • ROCKFORD • ILLINOIS

NYE'S WATCH & CLOCK OIL

For INSTRUMENTS

IT is a recognized fact the world over that porpoise jaw oil is the finest crude from which to refine lubricating oil for delicate instruments of precision. When the refining is done by the scientific processes developed through years of experience by Wm. F. Nye, Inc., the result is a specialized oil of the very highest quality.

Nye's Oil—100% American from "fish to finish."

Wm. F. Nye, Inc.
NEW BEDFORD, MASS.
ESTABLISHED 1844

For All **SCIENTIFIC** *Uses*

GALLET
GUINAND
and SECURITY
TIMERS

The Widest Selection of **TIMERS** and **CHRONOGRAPHS** Best Quality in every Price Range

FREE *Catalog on request*

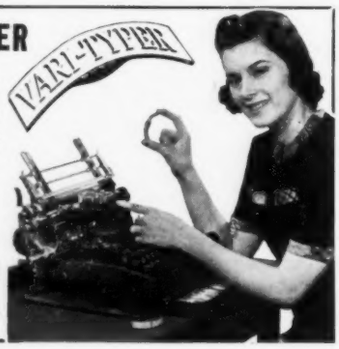
JULES RACINE & CO.
20 WEST 47th ST., NEW YORK

IT'S EASY TO SAVE MONEY WITH VARI-TYPER

Compose copy for your bulletins, sales manuals, booklets, catalogs, folders, etc., in *your own office* on the composing Type Writer with changeable faces and spaces. Any competent typist after proper instruction can Vari-Type your work to stencil, metal plate or photo-offset master copy with *large savings and improved appearance.*

● *Write Today for new specimen portfolio* "How to Profit by Using Vari-Typer" with actual samples of work produced.

RALPH C. COXHEAD CORPORATION
Manufacturers of Vari-Typer
333 SIXTH AVENUE NEW YORK CITY



The Scientific Way to Clock Fast Reactions

STANDARD ELECTRIC

STOP CLOCK

It's a practical necessity for split-second timing. Automatic measurement of elapsed time eliminates the manual error in research and production testing of thermal elements, relays, engine fuel consumption, liquid rate of flow and many other processes. Easy to operate. Ruggedly built for heavy-duty service. *Thirty day free trial.* For literature, prices, etc., write Dept. G.

THE STANDARD ELECTRIC TIME COMPANY
Springfield, Mass.... Branch Offices in Principal Cities
"STANDARD MAKES EVERY SPLIT-SECOND COUNT"

Meet the Necessity of Accurate Liquid Control With A LIQUIDOMETER

The Tank Gauge That Has Proved its Dependability

100% Automatic check-up on consumption.

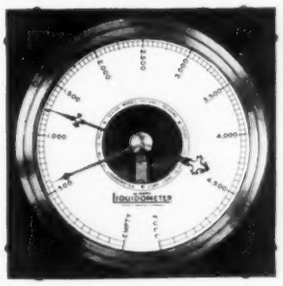
•

A convenient hazard-free legible reading whenever you require it.

•

No pumps, valves or auxiliary units required to get a LIQUIDOMETER tank gauge reading.

•



Balanced hydraulic transmission system ingeniously compensates for temperature variations on communicating tubing.

•

Accuracy unaffected by changes in specific gravity.

•

Approved by Underwriters' Laboratories and similar groups for measuring hazardous liquids.

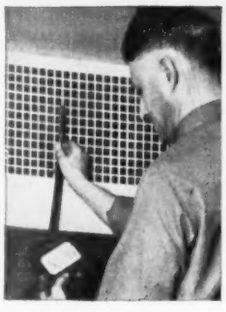
•

Remote or Direct Reading models available.

Write for complete details.

THE LIQUIDOMETER CORP.
36-27 SKILLMAN AVE. LONG ISLAND CITY, N. Y.

The All Purpose.... AIR VELOCITY METER



INSTANTANEOUS DIRECT READING

The Velometer is a versatile direct reading air velocity meter which gives instantaneous readings of the speed of air measured in feet per minute.

The Velometer is ideal for measuring duct velocities and pressures, velocities at grilles or registers. It offers the only convenient and satisfactory instrument for checking drafts, leaks around doors or windows or in ducts, velocities of ceiling outlets and similar air diffusers.

It is made in several standard ranges from 20 F.P.M. to 6000 F.P.M. and up to 3 inches static or total pressure. Special ranges available as low as 10 F.P.M. and up to 25,000 F.P.M. velocity and 20 inch pressure.

Anyone can use the Velometer. No mathematical calculations, no leveling—no timing.

Write for bulletin No. 2448-D

Illinois Testing Laboratories Inc.
142 W. Hubbard St. Chicago, Ill.

New, Simple, Handy, OHMITE Ohm's Law Calculator

Solves any Ohm's Law Problem with one setting of the slide

Figure amperes, watts, volts, ohms—quickly, easily! Requires no slide rule knowledge. All values are direct reading. Scales on both sides cover the current and wattage range for motors, generators, lamps, electrical apparatus and other applications up to 100 amperes or 1000 watts; also the low current high resistance Radio, Sound, and Electronic applications. Convenient Stock Unit Selector tells the stock number of the resistor or rheostat you may need. Specially designed by Ohmite Engineers. Size 4¼" x 9".

Send Coupon today, or write on company letterhead giving name and position. Enclose 10c in coin to cover handling cost.

OHMITE MANUFACTURING CO.
4887 Flournoy Street, Chicago, U.S.A.
10c in coin enclosed. Send Ohm's Law Calculator. *Please Print Clearly.*
Name.....
Firm Name.....
Position.....
Address.....
City..... State.....
Instruments—Feb.

BE RIGHT WITH OHMITE
RHEOSTATS RESISTORS TAP SWITCHES

The Only
Pressure Gauge
which Indicates with
DEAD WEIGHT
ACCURACY

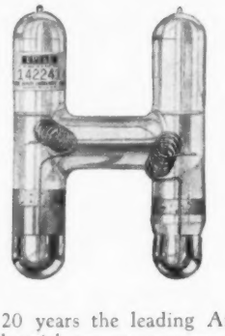
The world's most accurate pressure gauges

Heise Extreme Precision Gauges provide the quickest *reliable* way of testing: (1) for faster results where dead weight testers have been used, (2) inspectors' gauges, (3) new ordinary gauges. Indispensable to manufacturers of equipment which includes gauges. *Important feature:* revolving dial simplifies calculations by eliminating tare figure. Zero setting is instantaneous from front of bezel and self locking.

Note. Prices are surprisingly low. Example, $120 for a ten-inch (11¾" O.D.) gauge with 500 graduations.

HEISE Bourdon Tube Laboratories
275 NOBLE AVE. BRIDGEPORT, CONN.
In Collaboration with The A. H. Emery Co.

EPPLEY STANDARD CELLS
for
INDUSTRIAL USE



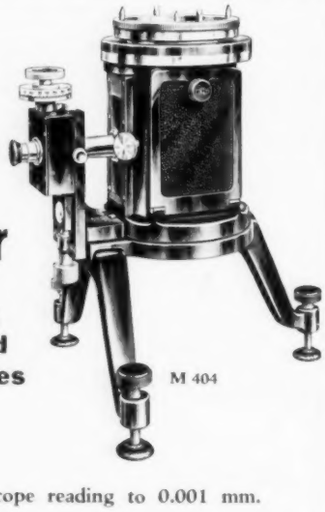
For more than 20 years the leading American manufacturers of industrial temperature control apparatus have used Eppley Standard Cells in their recorders, pyrometers and other instruments utilizing the potentiometric system of measurement.

When purchasing one of these instruments, make sure that the standard cell it contains is an Eppley cell.

EPLAB
THE EPPLEY LABORATORY, INC.
SCIENTIFIC INSTRUMENTS
NEWPORT, R.I.
U.S.A.

Gaertner Ring Spherometer

for measuring of concave and convex surfaces


M 404

with:

Micrometer Microscope reading to 0.001 mm.

Scale on plunger having a measuring range from +30 mm to —30 mm.

Four standard rings of 50, 40, 30, and 20 mm dia.

We invite your inquiries for THICKNESS MEASURING GAUGES for checking material up to 50 mm dia. and reading to 0.001 mm.

THE GAERTNER SCIENTIFIC CORP.
1211 Wrightwood Ave., Chicago, U.S.A.

Chicago Society for Measurement and Control

"Pressure Measurement at High Speed" was the subject of a four-speaker symposium at the February meeting of the Chicago Society for Measurement and Control. Preceded by a dinner, this meeting was held Feb. 10 at the usual place: the Central YMCA Auditorium, 19 S. LaSalle St. The speakers and their subjects:

A. J. Perkins (Underwriters Lebs): An Instrument to Measure Explosion Pressures.

A. S. Chipley (Burgess Battery): Engine Exhaust Pressures.

W. J. Faust (Universal Oil Prod.): An Instrument to Measure Detonation.

R. R. Procter (Pure Oil Mech. Lab): Electronic Instrumentation with Piezoelectric Crystals.

Subjects of coming meetings: *March*—Dimensional (Optical) Measurements; *April*—Industrial Electronics; *May*—Thermocouples.

For further information, address Carl R. Hope, Sec'y, 2626 W. 31st Blvd., Chicago (Phone Canal 4100).

Likes Our Temperature Instrument Serial

UNIVERSITY OF DETROIT

Instruments Publishing Company
Pittsburgh, Pa.

Dear Sirs:

In regard to the back issues of *Instruments*, I am sending you an order immediately for twelve copies each. While these are the October, November and December (1940) issues, I would appreciate a few (even one) of the September issue if there is any way of obtaining it.

By way of explanation I might say that our High Temperature Measurements Course for Junior Engineers will begin again with this coming semester with 35 students. There seems to me to be a lack of material for class-room work which is comparable to the Pyrometry articles in these issues. This is also the opinion of Mr. R. J. McCausey of the Detroit Edison Research Laboratories, a former member of our department.

WILLIAM M. BAKER,
Assistant Professor of Physics

January 15, 1941

MANUFACTURERS' NEW LITERATURE

In this department we report ALL pieces of NEW literature pertaining to Instrumentation, received from the manufacturers. Readers may secure without cost (unless noted) any or all items reported here, by filling out and mailing the coupon.

I-31 **Pyrometers.** Catalog 15E, 7⅞" × 10½", 24 pages, describes and illustrates indicating, recording and controlling pyrometers millivoltmeter type; also includes data on Diesel engine pyrometers, marine type pyrometers and portable pyrometers. Brown Instrument Co., Wayne & Roberts Aves., Philadelphia, Pa.

I-32 **Steam and Water Mixer-Heater.** Bulletin No. 840, 8½" × 11", 2 pages, covers industrial injection type heater which mixes high pressure steam (50 to 150 lbs.) with cold water at 30 lbs. or less, to furnish hot water at desired adjusted temperature. The W. J. O'Brien Co., 205 Harrison St., Syracuse, N. Y.

I-33 **Boiler Feed Regulator.** Bulletin, 8½" × 11", 6 pages, describes and illustrates regulator which controls the flow of water into the boiler so as to keep the boiler water level at the desired height; entirely self-contained and goes right in the feed water pipe at each boiler and can be entirely supported by the pipe. Henszey Co., Watertown, Wis.

I-34 **Self Regulating Battery Charger.** Descriptive data 27-435, 8⅜" × 10⅞", 4 pages, covers "Rectomatic" copper oxide battery charger for floating service; designed and adjusted to maintain a battery at its correct voltage, 2.15 volts per cell, under any condition of load within its rating at normal ambient temperature. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

I-35 **Audio Frequency Oscillators.** Bulletin, 8⅜" × 11", 4 pages, describes and illustrates resistance-tuned oscillators for distortion measurements on audio amplifiers, broadcast transmitters and other equipment; provide source of voltage for accurate bridge measurements and other uses. Hewlett-Packard Co., 481 Page Mill Rd., Palo Alto, Calif.

I-36 **Time Control of Reversal.** Bulletin T-31, 8½" × 11", 2 pages, describes and illustrates firing-reversal timers for use in controlling the firing of regenerative furnaces, typical applications covered are in the steel and glass industrial. Automatic Temperature Control Co., 34 E. Logan St., Philadelphia, Pa.

I-37 **Electro - Titrator.** Booklet 1283, 6⅞" × 10", 22 pages, describes and illustrates instrument for electrometric titration—the "G & D" titrator based on a vacuum-tube voltmeter circuit, consists essentially of two components, the laboratory accessories and the electrical equipment. The former are attached to the upright pillar, whereas the latter is contained in the base of the titrator. E. Leitz, Inc., 730 Fifth Ave., New York City.

I-38 **Aircraft Clock.** Bulletin, 8½" × 11", 2 pages, describes and illustrates Type WC 7 jewel, 8 day and 22 movement clock with Air Corps type dial having only the major hours showing; case is of phenolic composition, splash and dust proof and non-corrodible. Elgin National Watch Co., Precision Products Div., Elgin, Ill.

I-39 **Launder-Ometer.** Sheet, 8½" × 11", 1 page, announces improved laboratory instrument with preheated loading table starting all samples at same temperature, tray pre-heats all accessories (jar tops, rubbers, balls) to constant temperature through a circulating system integral with the reservoir or tank, insulated tank on electric models. Atlas Electric Devices Co., 361 W. Superior St., Chicago, Ill.

I-40 **Plastic Tester.** Bulletin, 8½" × 11", 2 pages, covers "Kaydel" tester for determining moisture content of plaster; weight is 20 ounces and extension contactor is less than 5" long having 4½' cable. Hart Moisture Gages, Inc., 126 Liberty St., New York City.

I-41 **Tachometers and Frequency Meter.** Bulletin 1670, 6¾" × 10½", 4 pages, describes and illustrates "Frahm" vibrating-reed tachometer for stationary mounting or hand use, ranges available from 900 to 30,000 r.p.m.; also frequency meter operating on tuned reed principle from 15 to 500 cycles per second. James G. Biddle Co., 1211-13 Arch St., Philadelphia, Pa.

I-42 **Test Instruments and Time Switches.** Bulletin GEA-2753, 8" × 10½", 4 pages, describes and illustrates a-c. hook-on volt-ammeter, portable test, inkless recording, strip-chart recording and round-chart recording instruments, time meters and time switches. General Electric Co., Schenectady, N. Y.

I-43 **Bodine "Motorgram."** Vol. 20, No. 5, 4 pages, has feature article on the care of fractional horsepower motors, data on "Stroco" electric arc crater eliminator and several other items. Bodine Electric Co., 2250 W. Ohio St., Chicago, Ill.

I-44 **Electric Contact Thermometer.** Sheet, 8¼" × 10⅞", 1 page, describes and illustrates adjustable thermo-regulator with resettings said to be possible within a few seconds, temperature range from 85°C. to 175°C. but can be made for other ranges. Price included. Brabender Corp., Rochelle Park, N. J.

I-45 **C-D "Capacitor."** Vol. 4, No. 7, 16 pages, contains Part II of article "Analyzing Radio Noises" and a number of radio service hints. Cornell-Dubilier Electric Corp., Hamilton Blvd., South Plainfield, N. J.

I-46 **Electric Time Control Devices.** Bulletin B-10, B-11 and A-20, 8¾" × 11¼", 5 sheets, cover automatic reset timers synchronous motor driven M-Series and P-Series and time delay synchronous motor driven Series TD-60. Industrial Timer Corp., 1034 Edison Pl., Newark, N. J.

I-47 **Stroboscopes.** Form 420-C, 8⅜" × 11", 4 pages, describes and illustrates the "Strobotac" and "Strobolux" and their applications in various industries. General Radio Co., 30 State St., Cambridge, Mass.

I-48 **"Cenco News Chats."** No. 30, 28 pages, contains biographical sketch of John Dalton, scientist, items on vernier calipers of stainless steel, mercury vapor pump of steel, electron oscillograph, magneto electric impulse generator and various ideas for laboratory work. Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.

I-49 **Dissolved Oxygen Recorder.** 3 sheets, 8½" × 11", describes and illustrates oxygen recorder with 10" strip chart, chart speed of 1" per hour. Standard ranges of the instrument are 0-1 p.p.m. dissolved oxygen or 0-2 cc. per liter. Schematic diagram included. Cambridge Instrument Co., Inc., Grand Central Terminal, New York City.

I-50 **Aircraft Compass.** Bulletin, 8½" × 11", 2 pages, describes and illustrates Type CG compass, mounting dimensions conform to AN and SAE standards for 2¾" dial instruments, spherical bowl is of phenolic composition (a hot molded plastic), front glass of magnifying type. Elgin National Watch Co., Precision Products Div., Elgin, Ill.

I-51 **"Solving Industrial Crimes."** Case No. 25, 4" × 5½", 16 pages, lists high speed meters for recording changing values such as electrical disturbances in power plants and substations, rapidly changing pressures, etc., speed recorders and indicators, recording ohmmeters, time recorders, pressure recorders, portable current transformers, etc. The Esterline-Angus Co., Inc., Indianapolis, Ind.

Clip and Mail this Coupon

INSTRUMENTS, Pittsburgh (FEB. 1941)

Please have the following catalogues, etc., reviewed in this issue sent to me.

Numbers .....

.....

I also desire further information concerning the following new products described in this month's "New Instruments" Department .....

.....

I also desire further information concerning the following products advertised in this issue (Write page number and name of company) .....

.....

Name ..... Firm name .....

Position ..... Address .....

I-52 **All-Use Wrist Watch.** Folder, 6 pages, covers "Multi-Chron" watch which is also a telemeter, timer and tachometer; mechanism is a 15 jewel Gallet movement and encased in "Stabrite" steel. Jules Racine & Co., 20 West 47th St., New York City.

I-53 **"The Laboratory."** Vol. 12, No. 2, 48 pages, contains article on E. & A. falling drop apparatus for making specific gravity tests; items on electron microscope, centrifuges and other laboratory data. Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.

I-54 **"The Graphic."** Bulletin No. 640, 8½" × 11", 16 pages, covers electric tachometers — description of generator, methods of moving the generator, connections between generator and instruments, description of recorder, etc. Esterline-Angus Co., Inc., Indianapolis, Ind.

I-55 **Air Compressors.** Bulletin H-621-B6C, 8½" × 10", 6 pages, describes and illustrates vertical single-cylinder single-stage Type VS air compressor. Machines are also suitable for operation as vacuum pumps. Worthington Pump & Machinery Corp., Harrison, N. J.

I-56 **Portable U Gages.** Bulletin No. 40, 8½" × 11", 1 page, covers U gage suited for butane gas tanks, also for testing wind box pressure on forced draft stokers and for oil and gas burner service; has unbreakable molded ⅜" tubes made from clear transparent compound. Defender Automatic Regulator Co., 308 South 8th St., St. Louis, Mo.

I-57 **Square Wave Generator.** Bulletin GEA-3442, 8" × 10½", 4 pages, describes and illustrates generator for testing over-all performance of communication systems and networks. General Electric Co., Schenectady, N. Y.

I-58 **Thermoregulator.** Sheet, 8¼" × 10¾", 1 page, describes and illustrates adjustable electric contact thermometer which may be reset within a few seconds. Its guaranteed accuracy is ±1/10th of 1°C. Brabender Corp., Rochelle Park, N. J.

I-59 **Tank Liquid Level Controls.** Sheet, 8½" × 11", 1 page, covers Model No. TF-5 tank float switch designed for flange type mounting with four ⅜" bolts, Model TF-6 switch featuring a 2½" screw-in type mounting and Model TF-1 which provides control of liquid levels on any tank application up to 25 lbs. pressure and permits an adjustable differential in liquid level control ranging from ¾" to 36" with the one standard instrument. Fred H. Schaub Engineering Co., 325 W. Huron St., Chicago, Ill.

I-60 **"G & D" Automatic pH Meter.** Catalog No. 1287, 7" × 10", 4 pages, describes and illustrates pH meter with circuit based on the Poggendorf voltage compensation principle. Voltage compensation is achieved electronically and automatically without the use of any moving parts. E. Leitz, Inc., 730 Fifth Ave., New York City.

I-61 **Universal Hydraulic Testing Machines.** Bulletin, 8½" × 11", 4 pages, covers Model 505 testing machines up to 60,000 lbs. capacity, for compression, tension and transverse testing. Riehle Testing Machine Div. of American Machine & Metals, Inc., East Moline, Ill.

I-62 **Aerovox "Research Worker."** Vol. 12, Nos. 5 & 6, each 4 pages, contain, respectively, articles entitled "Power Factor Correction" and "Use of L-C Checker for R.F. Measurements." Aerovox Corp., New Bedford, Mass.

I-63 **"Electroencephalograph."** Bulletin, 5" × 8½", 6 pages, announces new Junior "Electroencephalograph" apparatus for the recording of electrical potentials originating in the brain. Electro-Medical Laboratory, Inc., Holliston, Mass.

I-64 **Combustible Gas Alarm.** Bulletin No. DT-2, 8½" × 11", 2 pages, describes and illustrates explosion-proof alarm for safely and continuously sampling atmospheres where combustible gases and vapors may be present—in factories, refineries, oil tankers, etc. Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh, Pa.

I-65 **"The Ohmite News."** Jan. 1941 issue, 2 pages, contains article on Jean Baptiste Joseph Fourier whose mathematical contribution of the Fourier Series is important in the study of wave shape. Ohmite Mfg. Co., 4835 Flournoy St., Chicago, Ill.

I-66 **Air-Conditioning and Refrigeration-Compressor Motors.** Bulletin GEA-3479, 8" × 10½", describes and illustrates Type KG motors with triple-voltage connection and cast-aluminum Valv-amp rotor. General Electric Co., Schenectady, N. Y.

I-67 **Flue Gas Temperature Recorder.** Bulletin DMF 731, 8½" × 11", 4 pages, describes and illustrates Mono-Therm recording thermometers for flue gas temperatures. The Foxboro Co., 46 Neponset Ave., Foxboro, Mass.

I-68 **Oil Circuit Breakers.** Catalog 3650, 8½" × 11", 8 pages, covers outdoor circuit breakers of multiple single pole construction, weather-proof, can be supplied for manual operation or for electrical operation by either a d-c solenoid or a d-c. solenoid and a-c. rectifier. Roller-Smith Co., Bethlehem, Pa.

I-69 **General Radio "Experimenter."** Jan. 1941 issue, 8 pages, contains articles "A New Null Instrument for Measuring High-Frequency Impedance" and "Notes on the Care and Maintenance of Variacs." General Radio Co., 30 State St., Cambridge, Mass.

I-70 **Photometers and Accessories.** Catalog E-72, 7¾" × 10½", 20 pages, describes and illustrates entire line of photometers used for lamp testing, lighting surveys, photometric research and in educational laboratories; included are the bar photometer, sphere photometers (both visual and photoelectric types) and the Macbeth illuminometer. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa.

I-71 **Universal Type Hand Tachometers.** Bulletin No. 750, 8½" × 11", describes and illustrates "Standco" hand tachometer, direct reading, centrifugal type; supplied in four standard range combinations, covering speeds between 30 and 48,000 r.p.m. Herman H. Sticht Co., Inc., 27 Park Place, New York City.

ADVERTISERS IN THIS ISSUE

	Page
American Electrical Sales Co., Inc.	A6
Bailey Meter Company	33
Barber-Colman Company	48
Continental Electric Company	A6
Coxhead Corp., Ralph C.	48
Electric Tachometer Corporation	46
Engel, Inc., H. C. M.	32
Eppley Laboratory, Inc.	50
Gaertner Scientific Corporation	50
General Radio Company	Back cover
Gordon Company, Claud S.	A6
Heise Bourdon Tube Laboratories	50
Illinois Testing Laboratories, Inc.	49
Leeds & Northrup Company	A4
Liquidometer Corporation, The	49
Littelfuse, Incorporated	A6
Meriam Company, The	A2
Mine Safety Appliances Company	47
Moeller Instrument Company	45
National Electric Controller Co.	46
Nye, Inc., Wm. F.	48
Ohmite Manufacturing Company	49
Permo Products Corporation	48
Philadelphia Thermometer Company	A4
Racine & Company, Jules	48
Rawson Electrical Instrument Co.	46
RCA Manufacturing Company	A1, 45
Rubicon Company	35
Shore Instrument & Mfg. Company	32
Standard Electric Time Co., The	49
Tagliabue Mfg. Co., C. J.	Inside front cover
Taylor Instrument Companies	A3
Triplett Electrical Instrument Co.	47
Ward Leonard Electric Company	47
Weston Electrical Instrument Corp.	Inside back cover
Wheelco Instruments Company	35

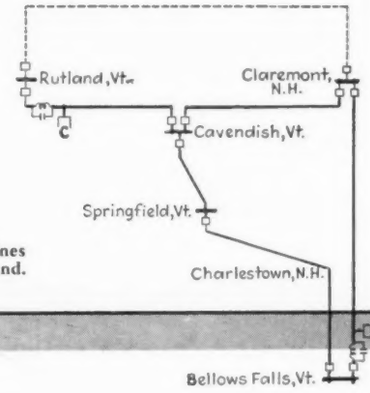
TRU-VAC
VACUUM GAUGES
(PIRANI TYPE)
Priced From $39.50
Circular on Request.
CONTINENTAL ELECTRIC CO.
GENEVA, ILLINOIS

Vacuum - - - Thermocouples
featuring
DEPENDABLE STABILITY
HIGHER OVERLOAD
FASTER RESPONSE
Our thermocouples will meet the most rigid requirements. Write your requirements to—
American Electrical Sales Co., Inc.
67 E. 8th ST. NEW YORK, N. Y.

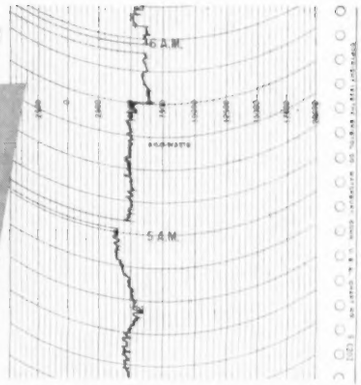
FUSES
Cut meter expense by fusing with Instrument LITTELFUSES. Other Littelfuses for auto, radio, high voltage, aircraft. Neon testers and indicators — all types of fuse mountings. Send specifications today for recommendations and samples. Ask for catalog.
Littelfuse, Incorporated 4759 Ravenswood Ave. Chicago, Ill.

INDUSTRIAL INSTRUMENT SERVICE
CLAUD S. GORDON CO., Cleveland—Chicago—Indianapolis

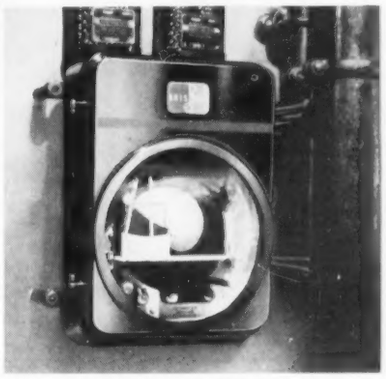
CARRIER TELEMETERING HELPS CENTRAL VERMONT PUBLIC SERVICE *constantly check tie-line load*



General layout of transmission lines between Bellows Falls and Rutland.

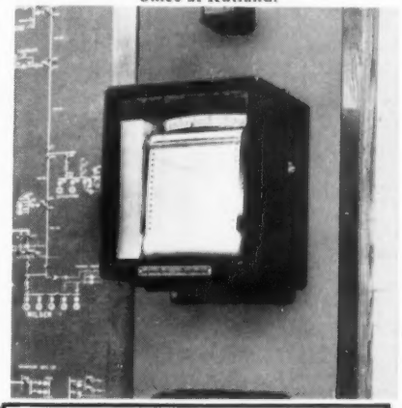


Typical kilowatt transmission record charted by Metameter Receiver.



Above: Metameter transmitter at Bellows Falls Station.

Below: Metameter Receiver in dispatcher's office at Rutland.



Here, too, Bristol's Metameter simplifies dispatching, cuts costs

IN ORDER TO KNOW at all times the power that is passing over the tie-line at Bellows Falls, Vt., between its own system and that of a neighboring company, the Central Vermont Public Service now relies upon a Bristol's Metameter System for telemetering.

Located at Bellows Falls, the Metameter Transmitter continually measures this power interchange and transmits the measurements over a carrier circuit to the load dispatcher's office in Rutland, fifty miles away. Here the measurements are accurately recorded, without interruption and without distortion, on the large easy-to-read chart of the Metameter Receiver.

For this purpose, as for numerous other applications, Bristol's Metameter is proving again and again that it is an accurate, dependable, convenient, simple, and surprisingly low-cost means for remote measurement of any quantity. It simplifies dispatching. By continually giving a visual picture of what is happening in the system, it enables the dispatcher to operate the company's facilities at peak efficiency and minimum cost. For full information, write for Bulletins 515W and 530W.

THE BRISTOL COMPANY
WATERBURY, CONNECTICUT
Branch Offices: Akron, Birmingham, Boston, Chicago, Detroit, Los Angeles, New York, Philadelphia, Pittsburgh, St. Louis, San Francisco, Seattle. Canada: The Bristol Company of Canada, Limited, Toronto, Ontario. England: Bristol's Instrument Company, Limited, London, N.W. 10

BRISTOL'S
TRADE MARK REG. U. S. PAT. OFFICE
Metameter
SYSTEM OF TELEMETERING

INFORMATION CONTINUALLY SUPPLIED BY BRISTOL'S METAMETER

FOR LOAD DISPATCHER OF CENTRAL STATION SYSTEM

1. Load (active and reactive power and power demand) in each tie-line interconnecting system with neighboring system
2. Output, or total generated power, of each generating station
3. Total output of all generating stations, on a single instrument
4. Active and reactive power and power demand at key points on important transmission circuits
5. Water level and waterwheel gate position in hydroelectric plant

FOR OPERATOR OF GENERATING STATION

1. Total output generated in system
2. Output of each associated attended or unattended generating station in system
3. Desired output of operator's own station

Other Services performed by Bristol's Metameter

ADJUNCT TO AUTOMATIC REGULATION OF GENERATING STATION OUTPUT FOR

1. Holding tie-line power or power demand within the desired limits
2. Introducing a tie-line load continuous bias into the automatic frequency controller.
3. Providing automatic adjustment of load between stations, and even between individual generators in the same station

AUTOMATIC CONTROL OF INDUCTION OR STEP VOLTAGE REGULATORS

1. Holding power or power demand in one of several interconnections within desired limits
2. Holding the power flow in a loop transmission circuit within the desired limits

FACTS OVER ANY DISTANCE